Assessing the Property Market Impact of Stigma Removal: High Voltage Overhead Transmission Lines Removal in Wellington, NZ

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High Voltage Overhead Transmission Lines, HVOTL removal, Impact on property value, NIMBYs, Property values, Stigma, valuation.

Abstract

The impacts of stigma on property values, and the length of time the stigma remains, are important determinants in the valuation of property. This research uses a case study in Wellington, New Zealand, where the High Voltage Overhead Transmission Lines (HVOTLs) were removed in the mid 1990s.

Data is analysed through a hedonic pricing model both before and after the removal of the HVOTLs. In addition, an empirical analysis of the sales data and demographics is carried out determining trends in the market from six years prior removal to fourteen years after removal. Lastly, individual case studies were chosen to analyse repeat sales.

The research determines that the decrease in value that is attributed to the presence of the HVOTLs is underestimated. The removal of the HVOTLs creates a value change across the whole neighbourhood rather than just the adjacent properties. The increase in value is not a sudden event; instead, the stigma gradually reduces over a period of three to four years as the market adjusts.

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Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signature: QUT Verified Signature

Date: 14 May 2014

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Chapter 1: Introduction

This chapter provides an introduction to the thesis, including a background to the research problem. The research questions are then stipulated along with the proposed methodology. The structure of the thesis is also outlined providing for easier navigation throughout the report.

1.1 BACKGROUND

Owning property is the backbone of wealth for the majority of people within most developed countries. Property may be in the form of the land and buildings that we live in and call *home*, or it could be an investment property that is designed to provide cash flow or capital growth, to form part of a retirement fund. However, property isn't restricted to the place where we live, as it also includes the place we work and the land we use for primary production. For most people, owning property (particularly the family home) invokes strong emotional feelings and therefore any movement of property values will affect both the personal wealth base and the safety and security of their home.

There are many examples in history when an event has caused a negative perception of a property resulting in a negative impact on the property's value. These events can include a wide spectrum of events including natural disasters (which cannot be predicted or controlled) through to man-made structures that are placed within a community.

Property values also play an important role in the economy as a whole. They provide information for buyers and sellers, provide input in legal cases, set the rating tax base, and form the predominant wealth base for most people within the developed world. For this information to serve its purposes, first it needs to be correct, and second it needs to reflect accurately the impact of external effects. This second aspect has posed, and still poses, a major problem for Property Valuers. It is the impact of external effects on property values, the measurement of such impacts, and how long the stigma or impact lasts for, that forms the topic area of this thesis.

There has been limited research in the area of determining the impact on property values of having a stigma (structure or natural disaster) within the neighbourhood (McClusky 2003, Eves 2002, Callanan 1999, Roddewig 1996, Reed 2011). This research can be separated into a number of different categories; however, to make it manageable two general categories are used: impacts caused by natural disasters, and impacts caused by physical structures. The current research determines that there are various results, and the results from any single model cannot be applied across all areas or countries.

The research builds on that knowledge to determine the value impact that removing a stigma from the neighbourhood has on property values, in particular the removal of HVOTLs. The change in value results achieved from removing the structure can then be compared with the reduction in value that was placed on them while the structure was in place.

Technological advancement in the form of HVOTLs and wind turbine generators has put pressure on where to site these necessary structures. These structures are necessary within neighbourhoods but fall under the Not in My Back Yard Syndrome (NIMBY) – that is, residents know that the structure is necessary but they do not want it near their property (Dear 1992).

NIMBYs currently pose a problem in the valuation of properties, as there is no standard accepted adjustment that Valuers can use and that can be applied across different property types, neighbourhoods, cities or countries. Therefore, the research undertaken for this thesis should provide a better understanding of the impacts, and also provide a sound basis for applying the adjustments required within the valuation process.

This research is based on a case study using the Wellington suburb of Newlands where a HVOTL was removed in 1996. Wellington is the capital city of New Zealand and is located at the southern tip of New Zealand's North Island. Newlands is approximately ten kilometres north of Wellington's Central

Business District. A full description of the case study area is provided in Chapter 2 of this thesis.

1.2 CONTEXT

The NIMBY syndrome is a by-product of expanding population and modern technology. As cities become bigger there is a need for locating facilities such as prisons, transfer stations and other community facilities, within neighbourhoods that may not be immediately acceptable to those communities, with a subsequent impact on property values (Callanan 1999, Jaconetty 1996, Messer 2006). Technological advances have also brought about structures that have to be located close to the community that they are servicing, but residents do not want them located within close proximity or in view of their own property. These structures include mobile phone towers, telecommunication satellite dishes, high voltage overhead transmission lines (HVOTLs), wind turbines, and pipelines.

The term ‘Not in My Backyard’, or NIMBY, has been derived to reflect circumstances in which people accept that a structure or facility is required within the community, and that they may or may not benefit from it. However, they do not want the facility located in their neighbourhood or within direct view of their property. If it is located elsewhere – ‘Not in My Backyard’ – then it is acceptable.

The next chapter examines the literature relating to NIMBYs, including how they may affect property values. This thesis centres on the research questions regarding the effect of the stigma created by the NIMBY and how long the stigma lasts after the NIMBY is removed.

1.3 STIGMA REMOVAL

Stigmatised property has aspects other than physical location or functional attributes which have negative connotations with buyers. In the majority of cases these negative connotations are not immediately apparent and it is only from local knowledge that buyers become familiar with their existence.

Over recent years, natural disasters have been a very familiar occurrence in both Australia and New Zealand. Where areas have experienced flooding, bushfires, cyclones or earthquakes, some of these events are then recorded on local government property records and are therefore recorded forever. However, there are other times when natural disasters are not recorded, and as people's memories fade so does the impact the event has on property values. Even the incidences where the information has been recorded will also fade in memory as the land is tidied up and houses are rebuilt. Potential buyers may be aware, therefore, of the incident but believe either it will not occur again or not occur while they are living there.

Other forms of stigma can arise from events such as a notorious murder, suspected haunted houses, or any newsworthy story related to celebrities. In some of these cases the stigma can be turned to a positive impact as the property takes on a 'legendary' status.

The stigma referred to in this report concentrates on unwanted structures within the neighbourhood and how long the stigma lasts after the structure is removed. The case study area has HVOTLs within it. HVOTLs are a recognised NIMBY and this has placed a stigma on the area: buyers are fearful of perceived health risks, visual pollution and associated risks (Callanan 1995).

1.4 HIGH VOLTAGE TRANSMISSION LINES (HVOTLS)

The high voltage transmission lines are an essential physical structure throughout all countries. They move electricity in high volumes from the source of the power to the end destination. The lines are strung off towers of varying heights, and the height is dependent on the wattage being carried. The towers are generally very visible – they appear to march across the landscape.

The main concerns that people have in regards to living close to the HVOTLs are in relation to the potential health effects from the electromagnetic field and the visual impact (Bond & Hopkins 2000, Sims 2004). These concerns then lead to an unwillingness of buyers to live in close proximity and, therefore, may affect the property values as fewer buyers are in the market for these properties.

This thesis uses HVOTLs as a case study to analyse the impact their presence has on property values within the Newlands area. It then looks at the changes to these property values after the HVOTLs are removed, and how long the stigma takes to disappear, or is no longer a part of the buyer's decision making process.

1.5 GAP IN LITERATURE

The literature review, as shown in chapter two, highlights that the gap in literature and knowledge is in regards to the impact on property values on the removal of HVOTLs from a neighbourhood. The literature covers the impact of HVOTLs on property values, but not on the impact of the removal of the HVOTLs. The literature is also, lacking in knowledge in the area, of how long the stigma remains once the HVOTLs or NIMBY structure is removed, before the property values adjust to a level they would be at, had the HVOTLs not been there.

1.6 RESEARCH PROBLEM

The current literature and industry practice provides a benchmark in regards to what Valuers use to adjust the market value when there is a stigma or HVOTL in close proximity. The hypothesis is that when the stigma is removed there is a more profound impact on value, as the area becomes more desirable to a larger portion of buyers. The research problem is based on whether this positive increase is the same or greater than the negative impact amount attributed to it while it is still in place, and then how long the stigma lasts once the structure is removed. A case study is used as a basis for analysing the sales after a NIMBY (in the form of a High Voltage Transmission Line) has been removed from the area, which allows for sales and property information to be obtained both prior and after the removal.

1.7 RESEARCH QUESTIONS

The research explores the problems faced in determining the impact of a NIMBY on property values, and then how long the attached stigma lasts once the HVOTL has been removed.

Two key questions have been developed for attention within this thesis.

1. Does stigma related to HVOTLs create a negative impact on property values?
   a) What is the effect on residential property values from stigma?
   b) Are there changes within the neighbourhood demographics with the creation or removal of a stigma?

2. Once the structure has been removed:
   a) How long does the stigma last for?
   b) Does the value difference from removing the stigma, vary from the adjustment that purchasers make when purchasing while the NIMBY structure is still in place?

1.8 IMPORTANCE OF THE RESEARCH

Under current valuation practice, the presence of an external effect, or NIMBY such as a HVOTL, would be dealt with by subtracting a percentage or dollar amount from the total value. In New Zealand this is currently an arbitrary figure and very subjectively related to how the Valuer perceives the HVOTLs (Gibson 1984). This research endeavours to provide a better understanding for all participants within the Property industry, in particular the Valuation profession, in relation to how long the stigma lasts after removing the structure. In addition to understanding the stigma effect, Valuers will be able to apply this knowledge when calculating the adjustment factor for properties that are currently affected by stigma.

1.9 RESEARCH METHOD

Due to the nature of property valuation, where the primary objective is to determine the likely market value of a given property on a specified date, this value is based on a number of factors such as floor area, land area, location, age, construction type. The most applicable method for researching this value is to use a Multiple Regression where the value is the independent variable and the determining factors are the dependent variables. A paired data and repeat sales index will be used to analyse sales that are part of the case study area to determine how prices have changed between the removal of the structure and fourteen years later.

1.10 THESIS OUTLINE

The research will be undertaken as follows:

Chapter 1 **Introduction**

This chapter introduces and provides the background to the research topic. It provides the research questions and methodology, which form the basis of this thesis.

Chapter 2 **Literature Review**

In this chapter a review of the literature has been carried out establishing the research issues and gaps in the current knowledge in this area, with emphasis on the models used and the findings to date.

Chapter 3 **Research Design**

Within this chapter the research method and methodology are discussed, with a justification as to why the quantitative and empirical methods were chosen as the main techniques.

Chapter 4 **Results and Discussion**

This chapter analyses the data at the time that the HVOTLs were in place and then fourteen years after the removal of the HVOTLs to determine the impact of the removal and also how long it took for the stigma to disappear. The results are then applied to the research questions. An analysis is also carried out on the sales data along with a Repeat Sales index.

Chapter 5 **Conclusions and Implications**

This chapter discusses the conclusions and limitations as to how this information can be used by the Property Valuation industry and also by the general population who are looking to buy or sell property in an area where a stigma exists.

The thesis is then concluded with References and Appendices.

1.11 SUMMARY

This chapter has introduced the research question and provided a brief introduction to the methodology and research problem, followed by the thesis outline. The next chapter critically analyses the literature related to the research problem and questions.

Chapter 2: Literature Review

2.1 INTRODUCTION

In Chapter 1, the thesis was introduced along with a background to the research questions and an outline of the structure of the thesis.

This chapter provides a review of the relevant literature in relation to different types of stigma and how stigma has been treated in regards to determining property values. As the case-study is based upon the treatment of HVOTLs, a review of the literature in this area is also included. The chapter concludes with a review of the literature relating to methodology. Chapter 3 explains the methodology to be used for the research.

2.2 BACKGROUND

This literature review concentrates on facilities or structures, which are not ‘permitted’ activities and which are placed within a residential zone. The literature relating to a variety of stigmas has been examined, including mental health or community housing facilities (Hargreaves & Callanan 1998), as this is an external effect that is different from the High Voltage Overhead Transmission Line (HVOTL) cases. A HVOTL is a structure that creates a visual impact as well as the fear of adverse health effects for nearby residents (Sims 2005). Generally, a mental health or community housing facility is a property that is homogeneous with the surrounding neighbourhood; therefore, the visual impact is minimised. However, the resistance from neighbours comes from fear for their physical safety.

There are many examples of external effects that may be placed within a residential neighbourhood, e.g. community or social housing, mobile phone towers, transfer stations, HVOTLs. They all fall under the following categories: a fear of property values declining, physical safety, health, and visual impact. This thesis concentrates on facilities or structures placed within a residential zone where residents can expect a high level of amenity value. The methodology employed in environmental effects such as air or noise contamination is similar; however, a distance effect cannot be measured as air contamination generally affects the wider community. This research is based on those structures or facilities that are placed in a residential neighbourhood for the ‘good’ of the whole community, but only a small proportion of the community are paying for that good in terms of lower property values.

Major problems lie in isolating the effect as there are only a relatively small number of properties within close proximity to the HVOTLs. Therefore it is difficult to obtain a statistically significant equation on such a small database. The second problem is the form of the equation. Other problems include how long the effect lasts if the structure is removed, and how to measure a subjective variable?

The technique used for measuring the impact of external effects (especially where there is a small sales database) is also examined. The results need to be tested on a regular basis in order to monitor the continuing accuracy of the model. By carrying out a before and after analysis using the Newlands suburb of Wellington as a case-study, and also analysing sales in an Auckland case-study (Callanan 2011), it was decided that a multiple regression analysis was the best approach to use in the New Zealand context.

Before reviewing the literature on specific stigma effects, it is important to understand the psychology behind the Not in My Back Yard (NIMBY) syndrome, which is the basis for most stigma effects.

2.3 NOT IN MY BACK YARD SYNDROME (NIMBY)

Before embarking on any study into the effects of NIMBYs on property values a number of questions need to be asked of the study site (Callanan 1999).

The first question to determine is: is the structure or facility in fact unwanted by the immediate community? There are certain facilities, which may be strongly opposed in one neighbourhood but supported in another where the needs of that community are met by the facility.

The second question is: has there been notification of, or provision for, the intended introduction of this facility in either the local government District Plan or through a city council Land Information Memorandum? If there has, then adjustments to property value will be spread over the period between notification and introduction, rather than a brief period of time.

The third question is: how prominent is the facility or structure? If good landscaping can effectively screen the structure then the effect is expected to be less than a structure that is not screened. Similarly, if the facility is unobtrusive and set back from the street, being homogeneous with its neighbours, then surrounding property values are less likely to be effected than where there is a prominent feature.

The fourth question is: as aesthetics are an important part of the buying equation for potential purchasers, are the aesthetics acceptable? Appearance is very important to the acceptance of the facility or structure. In responding to the fourth question, it is important to assess whether the aesthetics will have a negative or positive effect on the environment.

The final question is: if the NIMBY is a structure such as HVOTLs then are the immediate neighbours the only beneficiaries of the power being carried and therefore getting the benefits and the costs?

2.3.1 Minimising the NIMBY effect

As there will always be cases where a NIMBY has to be placed within a neighbourhood, or a stigma is created, it is important to be aware of the most appropriate methods to minimise these impacts.

2.3.2 Installing a new NIMBY into the community

Hilen (2003) provides a report on the route planning and design process that will minimise opposition to a new route for HVOTLs. Opposition is identified as coming from health fears, impact on environment, and impact on property values. As with the installation of any NIMBY in a neighbourhood, it is important for the developer to provide alternative designs, routes and costing, and to demonstrate why the alternatives have been discarded and the proposed location is the optimal one. Hilen (2003) suggests the best process for gaining approval or community support as:

- Hire consultants early
- Engage local governments
- Engage community groups
- Select a sensible route (demonstrating that a rigorous process has been carried out to select this route)
- Acknowledge design weaknesses
- Don’t underestimate the level of public fears
- Don’t abandon civility in public relations.

These guidelines are also backed up by studies carried out by Yarbezinski (1992), Roddewig (1996), and Mundy (1992).

If the NIMBY is a structure such as HVOTLs then the question has to be raised as to whether the immediate neighbours are the only beneficiaries of the power being carried. If they are the only beneficiaries, then it may be appropriate for them to pay the costs. If communities beyond the immediate neighbours of the

HVOTLs are beneficiaries, then it would seem that the immediate neighbours shoulder disproportionate costs for the whole community through lower property prices. This raises questions of inequity

The following questions are set out by Callanan (1999) to be addressed prior to installing a structure or NIMBY into a neighbourhood.

- If the wider communities are the beneficiaries then the immediate neighbours will be shouldering a disproportionate cost.
- If the NIMBY is a facility, then is the local community going to benefit from the facility?
- Is there confidence in the developer? If the developer is working in open communication with, and building confidence within, the local community, then the effects can be minimised.
- Has there been any significant media attention related to health effects in regard to HVOTLs? Media attention, especially unsubstantiated reports saying there will be effects on property, can cause a bubble effect.
- How many other NIMBYs are placed within the community?
- Is the proposal worse than what is currently on site?

Developers can minimise the effect through being prepared for opposition and by thorough consultation with the community. The demographics of the community are also important. Communities with political influence or financial backing will be able to mount a more effective campaign against the developer than a low-income community. The second step raised by Maize (1992) is for the developer to put themselves in the community’s place and consider the problem from their perspective.

The developer needs to build up trust within the community and show through consultation that they are prepared to amend the development as a compromise for the community, therefore building up goodwill.

New York city adopted the ‘Fair Share’ policy in 1990 which requires the fair distribution among the communities of the benefits and burdens associated with city facilities with due regard for the social and economic impacts on the surrounding sites. Problems arose regarding saturation in some communities while others complained of a lack of facilities. Guidelines were drawn up which include the following objectives:

- Institute a participatory process that strives for consensus by involving all stakeholders early and on a continuing basis.
- Develop trust with an open process that admits mistakes, avoids exaggerated claims, and is responsive to citizen input.
- Get agreement that the status quo is unacceptable.
- Work for geographic fairness by, for example, siting multiple smaller facilities instead of a single large one.
- Keep multiple options on the table at all times so that a potential host community does not feel discriminated against and a fall-back option is available. (New York Fair Share 1990)

A suggestion which goes one step further is to ensure the host community is better off by providing benefits in the form of neighbourhood improvements, tax reductions, or avoidance of other NIMBYs or LULUs (Locally Undesirable Land Uses) (Weisberg 1993).

Other methods put forward for minimising community resistance have centred on providing the community with all the facts – do not try and hide things. Knowing who the opposition is and why they oppose is important to implementing the proposal with the minimum cost. Consultation with the community is paramount in breaking down resistance, as is being prepared to compromise and alter the project.

In determining the impact of LULUs on housing prices, Thode (2006) notes the challenges that an Appraiser may face, including selecting appropriate comparable sales to the study property, and determining whether other LULUs that may be in the neighbourhood are also impacting on the property's value.

2.3.3 Placement of NIMBYs within urban areas

Dear & Taylor (1982) identify five problems with analysing property values close to a NIMBY (in their study, a mental health facility). These problems will apply to any facility placed into a neighbourhood. They are:

- Defining the relative neighbourhood impact area.
- Controlling for 'noise' in the data.
- Using small scale facilities, which can be submerged in other market data.
- Finding a suitable control neighbourhood.
- Discounting for various inconsistencies in the data. (Dear & Taylor 1982 pg 16)

A three-pronged approach to analysing the data was taken by Dear & Taylor (1982). First, they looked at any effect on the volume of sales. To do this they used a control area and three time periods: before, during and after the introduction of the facility or structure. An impact area of 400 feet was chosen and sales were banded into 100 feet concentric zones. 'The actual percentage of sales in each area was compared with the expected percentage of sales expressed as the percentage of the total survey period in each time period.' (Dear & Taylor, 1982) Second, they examined whether there was a change in sale price by comparing the average house price in each area over the three time periods. To standardise the data, sales were deflated to one time period and then converted to price per room. The problem with this method is that the facility being studied is small scale (community house) and the effect will be lost, on using a 100-foot concentric band. Any effect is more likely to occur within the first 50 feet. The third approach used was a multiple regression analysis. The dependent variable was the deflated average sale price. The independent variables were broken into three sets: housing related variables, a location variable (dummy variable based on suburb) and thirdly a land-use variable which measured the percentage of neighbourhood devoted to commercial land use.

Four separate regression analyses were carried out based on the facility characteristics:

- The presence or absence of the facility in the neighbourhood
- The distance from the facility. It is not stated how this distance was measured
- The type of facility
- The number of facilities in the neighbourhood.

The study concluded that the most important factors influencing the house prices were the specific characteristics of each house particularly the number of bedrooms. The presence of a facility in the neighbourhood had a small effect but the analysis looking at sales volumes and prices had no effect, which suggests that the first result was due to other factors in the data.

An unpublished dissertation by Bretherton & Dowling (1996) uses an application for an air discharge consent by Wenita Forest Products in New Zealand to highlight the requirements by developers or corporations in successfully establishing a NIMBY.

The literature advocates for the following to occur to achieve a successful outcome:

- Extensive public consultation as early as possible
- Develop risk management programmes and remain flexible
- Establish and maintain trust between the development and the local community
- Contributing back to the local community (financially or through social benefits)

- Protecting neighbouring property values (this may require purchasing any that may be adversely effected). (Bretherton & Dowling 1996, pg 14)

Bretherton & Dowling (1996) found that Wenita did not follow any of the guidelines and appeared to adopt a bureaucratic attitude, which expressed itself in simply following the process. The application was declined following community opposition.

A study using 641 residential properties across seven counties by Colwell et al (1999) uses data as far back as six years prior to announcement of the provision of a group home, and six years following. Using all the observations and overlapping the sales through time so that all the announcements occur at time 0 achieve a type of event study. The group homes studied by Colwell (1999) are for people with mental illness or who are developmentally disabled. This is unlike the New Zealand situation where Community Housing caters for a wide range of people including ex-prisoners and psychiatric patients (Hargreaves & Callanan 1998).

Dear (1992) published a paper on the NIMBY syndrome, where he examines the nature of typical opposition arguments and the factors that determine community attitudes. This paper is based on a study of a group home being placed in a residential neighbourhood. He found that most residents concede that there is a need to have ‘noxious’ facilities including community or group housing, but not near to their homes, hence the term ‘not in my backyard’. The community opposition tends to be cyclical in nature with periods of intense and frequent disputes, followed by extended calms. In a previous study that Dear had undertaken in 1976 he states that each incident of locational conflict seems to follow a three stage cycle. The first stage of the cycle is ‘Youth’; this is when the news of the proposed house surfaces. The second stage is ‘Maturity’ which is when the debate begins, with both sides gathering support and putting their case forward. This is the stage where concerns about property value declines will be voiced, along with the perceived threat to personal safety. The third and final stage is ‘Old Age’. This is the period towards the end of the conflict if it has been a long drawn out procedure. Typically, at this stage, some kind of arbitration process is adopted, using professional or political resources. Both sides make concessions, or victory tends to go to those with the persistence and stamina to last the course.

None of the studies on real estate transactions in the vicinity of human service facilities has demonstrated a property value decline that could clearly be linked to the facility (Dear & Taylor 1982, Hargreaves & Callanan 1998). Property value changes tend to be associated with broader market movements, such as changes in interest rates or the arrival of large scale property developments nearby, like a new shopping mall. In some instances, neighbourhood property values have actually increased because the facility was so well maintained or renovated that it had a beneficial effect on its neighbours. (Dear 1992)

A universal factor in all NIMBY conflicts relates to geographical proximity (Smith 1981). The proximity factor should be obvious but is often underestimated. The closer residents are to an unwanted facility, the more likely they are to oppose it. Opposition runs high among those on the same block as a proposed facility. Two to six blocks away, neighbours interest or awareness declines to the point of indifference.

From a developer’s perspective, Yarzebinski (1992) carried out a survey and then makes suggestions as to how the developer can handle the placement of a NIMBY without raising the opposition to the facility. Opponents generally have a fear of the unknown. They tend to want to preserve the current status of their environment and therefore focus on the negatives of the development without offering any solutions to the problem. The developer must provide good communication and as much information as possible to the community.

2.3.4 Removing the NIMBY from the neighbourhood

The published literature is lacking in research on the effect of removing a NIMBY (where the NIMBY is a HVOTL) from the neighbourhood. There is no published research on whether there are any lingering effects and how long the stigma remains before the market adjusts. A further question that has not been addressed is how much society is willing to pay for placing a NIMBY near a select group of property owners? Moreover, are the current property owners necessarily those who require compensation, assuming that some at least bought their properties at reduced prices as a result of the NIMBY? (This is assuming the NIMBY has not been introduced after the purchase of the property.)

Stigma or fear is often a subjective perception, and whether they are logical or grounded in fact, they are not easy to reverse or alleviate.

Jackson (2001, 2002) carried out comprehensive research into the effects on Industrial property value following a clean-up of contaminated sites. He found that there was no difference in price between a clean site and one that has been cleaned up. This is not an unexpected result as the determinants for Industrial values are not the same as those used to determine Residential value, with the main exception being the removal of emotions and perceptions of residents from the equation. In both if Jackson's studies the log of sales price was used within the regression equation as the dependent variable.

As there is no published research in this area in regards to the removal of HVOTLs and their impact on property value, I have moved further afield to look at stigma resulting from a natural disaster such as flooding, earthquakes, fire and cyclones. With this type of event, stigma remains after the event. By looking at this literature we are able to get a better understanding of the length of time over which the stigma remains.

2.4 STIGMA/FEAR OF NIMBYS

Stigma or fear is behaviour or fear that people have which cannot be quantified and may or may not be substantiated. The presence of a NIMBY in a residential zone will invoke a certain amount of stigma or fear but may also involve an environmental visual impact.

‘Stigma as it applies to real estate affected by environmental risk, is generally defined as an adverse public perception about a property that is intangible or not directly quantifiable. It is an additional impact on value, over and above the cost of clean-up or remediation’ (Roddewig 1996).

As defined by Wilson (1993) ‘Stigma may be viewed as the marketplace’s reaction to the perception of a problem that will impact value … stigma may be defined as being composed of objective and subjective uncertainty’. The extent and duration of the decline in marketability and value relates to the real and perceived risks associated with owning, financing or enjoying the property. Mundy (1992) offers a definition that runs on similar lines, as follows; ‘An environmental stigma results from perceptions of uncertainty and risk.’

There are different stages that are evidenced in regard to stigma. If publication of a major study linking health effects to the NIMBY is released then subsequently public opposition will rise. This may cause a temporary or long-term adjustment, according to the extent of the findings. There will also be an increased level of resistance by the community if they feel the developer is not being ‘up-front’ with them or they feel duped. In order to minimise opposition the developer has to involve the local community in the process and be willing to adapt.

‘Collective participant opinion has a fundamental effect on the function of the real estate market and property values. Market participant opinion, perception and tastes all help colour the market, but also add complexity’ (Wright 1999).

2.4.1 Stigma associated with the presence of HVOTLs

A study carried out by Guidotti & Jacobs (1993) illustrates the effect of fear on property values. This fear can either be perceived or substantiated. The study was carried out in a suburb in Edmonton, Canada, where residents believed there was an increased risk of cancer from HVOTLs. This fear was unsubstantiated. Real estate values temporarily lost an average five per cent of property value. A community survey was carried out along with an analysis of movements in property values over the six months between the time the cancer risk was announced and the retraction.

There have been an increasing number of court cases in the USA in which fear, whether it is justified or not, has been allowed as compensation for any possible decrease in property prices. In the case of *San Diego Gas and Electric Company v Daley* (1988) the court accepted the argument that the public's fear would decrease his property value (even though Daley could not show that fear was reasonable). The judgement was upheld and the judge refused to hear any testimony on the reasonableness of the fear or the fact that no causal link between cancer and electro magnetic fields EMF had been demonstrated (Stazer & Otto 1997). In a well documented American case, *Criscuola v Power Authority of the State of New York* (188 A.D.2d 951, 81 N.Y.2d 79, 1988), the court held that claims for loss of value need not establish the reasonableness of fear or perception of danger or health risks from exposure to high voltage power lines. There is a public belief that some facilities or structures do impose a significant negative impact on property values and the USA courts are now accepting this.

As the basis of residential property valuation is based on the sales comparison approach, the existence of sales based on 'fear' is projected onto neighbouring property values. The term 'market value' is defined as the price on a specified date reached by a willing, fully informed, knowledgeable and not over anxious buyer and seller. If either party is not fully informed and knowledgeable regarding the NIMBY then the selling price cannot be described as market value and should not be used as a comparable sale within the sales comparison approach. This information is very hard for any Valuer to determine and therefore will be overlooked in the majority of cases, and as a consequence property values in the vicinity will decline.

The Valuer needs to carry out a complete evaluation of comparable properties, which may require collecting sales comparable to similar affected properties from further afield. Roddewig (1996) has compiled a list of factors to be included as follows:

- Type of environmental risk
- Regulatory framework affecting the risk
- Physical characteristics of the site
- Amount and quality of the testing, assessment, and monitoring
- Type and level of clean-up
- Date of sale
- Location
- Media coverage
- Conditions of the sale
- Use of the property
- Motivations of buyers and sellers
- Lenders attitudes.

Both real and perceived risks have to be taken into account when valuing the adjoining properties.

The majority of residential properties in New Zealand are valued using the sales comparison approach (PINZ: Valuation Standards 10.1.1); however, when valuing an investment rental property the income approach is also used. If there are health and safety concerns, or visually, with the property then tenants will pay below market rent and therefore affect cash flow. As the income approach is based on the cash flow this will reduce the property value. The occupancy level may also decrease as the marketability to tenants decreases; this will also have an impact on the cash flow.

When looking at wider external effects, there are a number of factors that determine community attitudes towards an external effect. The client characteristics are the most important, followed by the service facility itself.

Dear (1992) determined the following hierarchy of acceptance by home owners when assessing potential impacts on property values:

Table 2-1 Hierarchy of acceptance – Source: Dear (1992)

Most Welcome	School
	Day care centre
	Nursing home
	Medical centre
	Hospital
Mixed reviews	Group home (mentally impaired)
	Homeless shelter
	Alcohol rehabilitation centre
	Drug treatment centre
	Chronic mentally ill facility
Absolutely Unwelcome	Shopping mall
	Group home (AIDs patients)
	Factory
	Rubbish dump
	Prison

Note: HVOTLs are not ranked in Dear's assessment.

Following the type of service facility is the community perceptions of: type, size, number in community, operating procedures, reputation of the sponsoring agency, and appearance.

An alternative discussion is put forward by Lake (1993) who suggests that there is political conflict over the siting of most NIMBYs. The state on the one hand is trying to maintain property values and the coherence of the community, and at the same time are placing responsibilities back onto the community that the state is responsible for. Lake's argument is that the state should alter its behaviour and deal with the problem rather than pushing it onto the community.

Jaconetty (1996) states that the behaviour and beliefs of market participants have a direct effect on value. This poses a problem within the valuation process. Although buyers within the market determine the market value, when it comes to valuing the properties that are impacted by a NIMBY or stigma, the Valuer is required to apply judgment as to what this impact could be. As Delaney and Timmons (1992) have observed: 'Residential real estate appraisers without any experience in appraising properties near high-voltage transmission wires presumed and estimated a larger negative price effect than did experienced appraisers'

2.5 STIGMA ASSOCIATED WITH NATURAL DISASTERS

Natural disasters have also been a catalyst for stigma, as fears are associated with the potential for that event to happen again. Stigma related to natural disasters such as flooding in Australia, and more recently earthquakes, as a result of the major earthquakes in 2010 and 2011 in Christchurch (South Island of New Zealand). With the earthquakes in Christchurch it is a bit soon to see research literature in relation to stigma, and how long the stigma will last, as the 'events' are still occurring with over thirteen thousand aftershocks being felt up until January 2013, and the market is still adjusting to this. However there is a small amount of research around a similar large earthquake that occurred on February 3rd 1931 in Napier (North Island of New Zealand) (McSaverney 2012), and also the earthquakes within California USA (Beron et al 1997).

The Napier earthquake was 7.8 on the Richter scale and killed 256 people, injuring hundreds more. The land was lifted 2 metres and 40 square kilometres of seabed became dry. As with the Christchurch earthquake, the majority of the central business district was destroyed, although in Napier it was predominantly due to the widespread fires that occurred as a result of the earthquake (McSaverney 2012). Napier city was rebuilt in an art deco style, which was typical of the era, and has become a showcase within New Zealand of this style. There is no published research available from this event in relation to the property market or associated stigma effects.

However if we look further afield, the Loma Prieta (San Francisco) earthquake of 1989, which damaged 20,000 homes and killed 60 people, has seen a higher level of research, with the most prominent being by Beron et al (1997). This study concentrates on whether consumer-buying behaviour proceeded in a predictable manner that was consistent with the risk. The research does not go as far as determining how long the stigma lasted following this event. As with other natural events, the property owners had insurance against this risk, which helps to minimise the impact on property values.

2.5.1 Stigma associated with flooding

With the effects of global warming becoming more pronounced in every country, there has been an increase in the frequency of flooding worldwide. This has brought about an increase in research in this area examining the impact that flooding has on property values and also the stigma associated with properties located in areas that have been the subject of high media attention, associated with the flooding.

Lamond et al (2009) undertook a UK based study, using data from thirteen areas, which found that the effect could be as low as zero to a discount as high as 40 per cent. Within this study the authors also note that the results are very specific to the individual areas. The study used a repeat sales methodology, which, in conjunction with the Contingent Valuation approach, appears to be the more accepted methodology for studies in measuring environmental impacts on property as advocated by Palmquist (1982), and Lim & Pavlou (2007). Within each of these studies a control area was also used.

The use of the Repeat Sales methodology helps to eliminate a certain level of uncertainty as to whether the view is an important factor (Lamond 2007). This methodology allows the researcher to concentrate on the variation between one event and another. For example, the view and house have not changed but one sale is prior to the flooding event and the next sale is after the event.

An additional factor that was introduced by Eves (2004) was the conflict that Valuers are under with Buyers adding value to a property that has a river view, and at the same time having a negative effect from the potential for flooding. An earlier study by Eves (2002), which also looked at the impact of flooding on residential property values, used Matched Pair and Repeat Sales. Eves (2004) builds on findings by Speyrer & Rajas (1991) in regards to buyers around a USA lake area where the view of the lake was of higher importance than the risk of flooding.

Ding (2011) builds on the findings of Speyrer & Rajas (1991) and Eves (2004) with an analysis in the Brisbane area that confirms the previous findings that property that has a water view often attracts a premium and although the risk of flooding reduces this, the properties are still likely to appreciate over time at a faster rate than those properties without a water view. Following a flooding event the properties suffer a decrease in value; however, after a period of four to five years the stigma disappears (Reed 2011).

The study carried out by Reed (2011) used the median house prices, which, as Reed acknowledges, has its limitations particularly when the 'water view' variable is embedded in this median. However, the data collected was extensive and included variables for distance to the CBD and also the depth of the flood. Flooding can be defined from a minor event such as ‘water where it is not wanted’ to ‘A general and temporary condition of partial or complete inundation of normally dry land areas from overflow of inland or tidal waters from the unusual and rapid accumulation or runoff of surface waters from any source’ (Australian Government Geoscience 2013). Insurance companies also have a different definition of flooding which makes it quite difficult to determine the impact of a flood without the depth variable that Reed (2011) has incorporated.

As with the HVOTLs, the public perception of impacts from flooding is very similar. The public perception will be at its highest when there has been a recent flooding event (Reed, 2011; Eves, 2004). The major difference between the two events is that if the buyer is not aware of the previous flooding then there is no visual reminder when they are making their purchase decision. This is in contrast to the HVOTLs where a report of health effects, or media attention, may not be present at the time of purchase but buyers will always be able to see the towers and lines. In addition, the HVOTLs are in clear view of the buyer, whereas unless the sale is at a time of flooding, a previous flood, or the threat of flooding, is not visible. An additional fundamental difference between comparing a natural disaster (such as flooding, earthquakes and fire) against stigma attached to a man-made structure, is that the natural disaster can be insured against and remediated whereas the value impact of a HVOTL cannot be insured.

2.6 STIGMA ASSOCIATED WITH CONTAMINATED SITES

Another area of stigma and associated impacts on property values are contaminated sites. Messer et al (2006) carried out a study into the stigma effect on property values related to a clean-up of a superfund landfill site. They examine 34,000 properties within three miles of the sites over a thirty-year period in the California area. Messer et al (2006) concluded that the stigma remains as long as there was work continuing on the clean-up. Once the clean-up was completed the stigma was removed. The authorities held out a positive future for the site by promising the development of a golf course on the site; however, this is reported as not happening.

The findings from contaminated sites are useful to apply to this research, as unlike natural disaster events, which may occur again, a contaminated site is cleaned up and hopefully the event will not occur again. The difference with a contaminated site against the removal of HVOTLs is that even with the site being cleaned up, the site will always be recognised and recorded as being contaminated. This differs from HVOTLs where once the line and towers are removed there is no residual contamination.

2.7 HIGH VOLTAGE OVERHEAD TRANSMISSION LINES IMPACT ON PROPERTY VALUES

Research in the area of transmission line effects on property values is very limited, with the bulk of quantitative studies carried out in the United States of America (Kinnard 1997, Collwell 1990, and Kroll & Priestley 1991). A study has been undertaken in Canada by DesRosiers (2002); however, although this study adds value to the knowledge, it is based on a 400m wide transmission corridor, which is quite different to the New Zealand system where the HVOTLs are directly adjacent to private property. Sims et al (2009) and Gallimore & Jayne (1999) have been prominent in the UK while Callanan (1995, 1999, 2000) has undertaken hedonic studies in New Zealand, with Bond (2000) carrying out a perception study.

2.7.1 New Zealand studies

A benchmark study carried out in New Zealand; Gibson (1968), for Valuation New Zealand, used an indexing system and forms the basis for the Valuation industry in valuing properties in close proximity to HVOTLs in New Zealand. The study was carried out on urban properties in Christchurch and Auckland. The Christchurch study included both a superior residential locality and an average residential locality. In the superior locality a negative effect was apparent whereas in the average locality no effect was evident. The Auckland study was carried out in an average to superior area and the results showed that in a few cases the transmission lines did have an effect but that the majority of properties were not affected.

Gibson (1968) compiled a list of points to be considered by NZ Valuers in determining how the value of a particular property is affected by the passage of transmission lines over it. Although this document is out-dated, it is important to include it here as it is still the base document used by Valuation New Zealand. These points are:

1. **The character of the locality –** the extent to which transmission lines effect individual properties differs according to the nature of the locality.

2. **The condition of the market –** whether it is active or passive and, associated with this, the level of supply of the properties for sale.

3. **The positioning of the wires in relation to the boundaries of the property and the building itself**. For example, the lines may run the length of the section, or only across the rear boundary, or they may cross in front of the building.

4. **The type of dwelling, its size, and the size of the section**.

5. **The nature of the restrictions imposed by the easement or proclamation taking the land or airspace.**

6. **How the saleability of the property is affected**. Whether the buying market is reduced in scope because of the presence of the transmission lines; perhaps increasing the time taken for the sale to be effected.

7. **The terms on which the property is sold**, i.e. the relationship between mortgage finance and equity for non-affected and affected properties.

8. **The reaction of property owners whose properties are affected by the presence of transmission lines over them**. For instance, do they improve their properties and add to them?

As this list was constructed many years prior to the awareness of potential health risks, it would be expected that the following condition would be added to Gibson's list (1968), if it were constructed today:

9. The current knowledge on health effects; for example, if a recent negative finding is published, there will be less buyers in that market.

There were found to be two types of purchasers in property that are affected. These can be characterised as, first, the hesitant buyer who is likely to discount the property because of the presence of the HVOTLs, and second, the confident buyer who (seeing that property is being bought and sold) pays little or no regard to the presence of the HVOTLs.

The Gibson (1968) report concluded that however inconclusive may be the evidence in relation to wires passing over residential property, it is clear that the presence of a pylon on the site, or situated in close proximity to a property, has a detrimental influence on the property value. The suggested discount amount for this impact was ten per cent. However, it is not determined within the report what 'close proximity' meant: 10 metres, 20 metres, 50 metres or 100 metres?

A study undertaken by Callanan (1994, 1995) on the Newlands suburb of Wellington, NZ was the first of its kind published in New Zealand using econometric analysis to estimate the impact of the HVOTLs on property values. The study area had two sets of 110kv lines running through it, with the lines converging at the southern end of the suburb and then splitting out with one line going to the west and the other to the north. The results from the study show a 27%

reduction for properties within 10m of the pylon, 5% at 50m, 2% at 100m, and reducing to less than 1% at 200m. It is noted that the pylons were located in the backyard of some of the sales within 10 metres of the house. This is a unique situation and probably the most extreme case.

A similar study by Callanan (2011) used a different area within New Zealand: Pakuranga, a suburb of Auckland. The study produced very similar results with reductions of 20 per cent at 10m, 5 per cent at 50m, and 2 per cent at 100m. The main variation between the results of Callanan 1994 and the 2011 study, is that in the 2011 study there were multiple sets of lines, with part of the line going over private property and a portion of the line going through a transmission corridor, which doesn't have houses within 50m.

A perception survey by Bond (1995), Bond & Hopkins (nee Callanan) (2000) also studies the Newlands area. Bond's report found that the residents living near the lines think of HVOTLs in negative terms of up to 10% off the asking price. However, it is common practice in New Zealand to negotiate the asking price of a property, and it is within the realms of normality to reduce by up to 10%. The respondents' main areas of concern were: health and safety, property values, and aesthetics. These are consistent to findings in a similar study by Callanan (2011) in Auckland, NZ.

2.7.2 International studies

Quantitative studies carried out in regard to the effect of High Voltage Overhead Transmission Lines have predominantly been in the United States of America and Canada. This study highlights the difference between the USA/Canada studies and New Zealand in that New Zealand doesn't have a transmission line corridor easement through residential neighbourhoods, which can be landscaped in order to shield the obtrusive effect of the HVOTLs. In a large number of the USA and Canada studies the easement has been heavily planted in order to try and minimise the visual impact of the pylons. New Zealand is unique to the other countries where research in HVOTLs have been published, in that the transmission lines can run directly over residential property and pylons are placed on privately owned land.

Two of the most prominent researchers, using hedonic models, in this area have been Kinnard and Colwell. Kinnard’s earliest study dated 1967, showed there to be no noticeable effect in the property values, with a reference to this possibly being because the lot sizes are increased in size. Colwell picked up on this in 1979 with his conclusions highlighting the importance of holding all the important variables, such as lot size, as a constant amount. It is typical in new subdivisions to provide for larger lot sizes in close proximity to the HVOTLs. If this is not allowed for within the analysis then the positive impact from the larger lot size can overpower any negative of proximity to the HVOTLs. This study concluded that there was an impact, which reduced to a negligible amount beyond 200 feet. The study was conducted well before the well-published report by Floderous (1993), which determined there was a link between leukaemia and proximity to HVOTLs. This report created a lot of public interest and debate in the scientific world, but interestingly Kinnard and Colwell’s studies still appear to have similar conclusions in later studies, suggesting the Swedish and Danish health effect reports were not taken into account in buyers’ decision making processes.

Kroll and Priestley carried out a very comprehensive review and analysis of the published literature on HVOTLs in July 1992 for The Edison Electric Institute. Their review looked at appraiser studies, attitudinal studies and statistical analysis: in total they reviewed around 45 studies undertaken by themselves in the USA or Canada. Their findings were that, in about half the studies carried out, the transmission lines had not affected property values. The rest of the studies analysed showed a drop in property values of between 2 and 10 percent. Those properties that showed no effect were generally adjacent to a landscaped, integrated right of way, which is expected to have a positive impact. The report provided a summary as follows:

- Price decreases do occur, but they are usually not large
- Not all reasonable, systematic studies found a price decrease
- Negative price impacts can decrease over time
- The distances over which price impacts occur vary widely
- Factors other than proximity to an HVOTL are likely to be more important in determining sales price and property value
- It is preferable to incorporate both appropriate statistical analysis and opinion survey research in any proximity impact study, for optimum results.

Kinnard continued this review in 1997 with a study of the cases from 1994 to 1997. Kinnard cites the Delaney & Timmons (1992) study as being one of the most quoted perception surveys undertaken (at the time), where Appraisers were surveyed with the result showing a negative 10-12 percent reduction in value. Kinnard also cites significant studies by Kroll (1994), Colwell (2000), Priestley (1990, 2005), Jaconetty (1996), and Hamilton & Schwann (1995). Kinnard was very prominent in the research area of HVOTL impacts. However, since his passing in 2001 there have been no major studies reported from the USA; hence the reliance on older studies.

In 1998 Kinnard also produced a report, which studied six counties in Virginia USA. The majority of the sales were for vacant land and he found that the lot sizes were larger in close proximity to the HVOTLs. This in turn had an impact on the price paid for land, with Mobile Home sites having a positive impact, as compared to the single home sites. There was a negative effect on price in the areas that had the HVOTLs right of way encumbrance on them, but this can also be explained by the reduction in useable lot size. His conclusion from this study is that there is no systematic pattern of negative price impact for properties with a view of the HVOTLs.

A study carried out at the same time in Canada by DesRosiers (1998) showed a positive influence but the transmission corridor was on a well-wooded 400 foot right of way, which the adjacent properties had direct access to, thereby creating a positive attribute to the property. A subsequent report by DesRosiers (2002) on the same study area, of 507 houses located in Greater Montreal, Canada, expanded on the findings, reporting a premium of 13-19 per cent for properties adjacent to the easement. However, a view of the pylons has a negative effect of 10-20 per cent, with the outcome being that the positive of the easement is cancelled out by the negative if there is a view of the pylon or line. The proximity advantage reaches a maximum between 50m and 100m, and diminishes beyond 150m.

Two studies have looked at whether the impacts diminished over time when a new HVOTL was constructed or upgraded. Kroll & Priestley (1991) undertook a study in California. This study was based on 1400 sales over a 14 year period, using a number of different neighbourhoods, which were affected by a line upgrade. The resulting model explained over eighty per cent of price variation. Sales prices where the upgrade occurred dropped following the upgrade, with a decrease of around 5%, regardless of distance from the line. The study found distance effects to vary sharply by neighbourhood, with an overall distance effect apparent. The most consistent finding was a positive effect where the right of way was landscaped and developed for recreational use. The majority of the neighbourhoods studied showed that being adjacent to a line does not have a significant effect on prices, perhaps showing a balance between the negative effects and the advantages of not having a neighbour to the rear of the house and the open area created.

As the Kroll & Priestley study (1991) was undertaken over a fourteen year period, price was adjusted using the CPI for home ownership, and dummy variables by year are also included in some forms of the model to account for any local price variations beyond national trends. The study highlighted the difficulties encountered in applying economic methodology to the analysis of transmission line effects on property values, though a large data set was used encompassing 14 years of data, extensive field work was undertake and price indices were applied. The main difficulties were gathering information on the quality of individual homes, quality of building methods used over time, and on financing methods.

Results suggest that many circumstances, ranging from the size of the line and right of way to the general tightness of market conditions may affect the outcome for residential home and section prices over time.

A major study carried out by Colwell (1990) analysed 200 home sales in two Illinois neighbourhoods over an eleven year period. The transmission line is a 138kv line with a 50 foot right of way. This analysis looks at distance as the reciprocal of the distance, rather than a set of zones using dummy variables. The Colwell study includes much more information on characteristics of the property than other studies. He found that proximity to the transmission line has a slight negative impact of between 2% and 3% on property values, but that the effect is strongest within the first 50 feet and dissipates quickly after that, disappearing beyond 200 feet. A major limitation found in the Colwell study is that little adjustment was made for the effects of inflation over time, even though the study was over a 12 year time frame. The proximity to the right of way also impacted on the final result. Despite this limitation Ignelzi & Priestley (1991) found that the Colwell study is one of the more careful and systematic analyses of residential impacts.

Colwell (1990) states that there are three questions, which need to be answered in current research:

- Is there an impact?
- Does the effect diminish over time?
- How far out is the impact felt?

Unfortunately, Collwell and subsequent studies have been unable to answer the second question in regards to whether the effect diminishes over time, which is a gap in the literature, which this thesis will address.

A frequently cited study by Hamilton & Schwann (1995) demonstrates the importance of specifying the correct function form for the distance variable in order to carry out a regression analysis. They tested for both the visual effect and proximity by carrying out three separate regression equations. The study included 12,907 sales in Vancouver from 1985-1991. Within the sample there are 2364 sales within 200 feet of the HVOTL and 426 were adjacent to the HVOTL. This is a adequate representative sample taken over a six year time period. The distance was measured from each property to the centre of the transmission line right of way. A dummy variable was then used for whether the property was adjacent, between adjacent and 200 metres, and over 200 metres. All the properties within 200 metres of the transmission line were visited to determine whether they had a view of the towers or not. A mixture of dummy and continuous variables was used for the property specific variables. The distance variable used concentric zones, broken down into three zones: within 100m, up to 200m, and over 200m. A translog specification was used for the independent variables and a Box-Cox transformed dependent variable. Tests were carried out to correct for heteroscedasticity. The results indicate a statistically significant negative impact of 5.7% to those properties adjacent to the HVOTL, 5.8% at 100m, and then 2.8% at 200m. The properties that did not have a view were not affected, losing approximately 1%. No mention is made of any adjustment for time or location, other than ‘the time frame corresponds to a relatively stable period in the market place’. They find that ‘neither the height of the transmission structures nor the voltage of the lines are found to have significant impact on property values. Other neighbourhood factors dominate the explanation of variations in property values’ (Hamilton & Schwann 1995 pg 441).

Kinnard (1997) looked at the effect of electrical substations on property values carried out in a similar study. In this study it was found that ‘the best models were so-called Log-Linear models, in which the Natural Logarithm of Sales Prices was the dependent variable, and all the independent variables are linear' (Kinnard 1997 pg 21). This is a similar model to that used by Hamilton & Schwann (1995).

Hamilton & Schwann (1995) demonstrate the importance of specifying the correct function form for the distance variable to carry out a regression analysis. They tested for both the visual effect and proximity by carrying out three separate regression equations. The distance was measured from each property to the centre of the transmission line right of way. A dummy variable was then used for whether the property was adjacent, between adjacent and 200 metres, and over 200 metres. All the properties within 200 metres of the transmission line were visited to determine whether they had a view of the Pylons or not. It is not specified as to whether the 200 metres was measured to directly under the transmission line or to the edge of the transmission right of way. A mixture of dummy and continuous variables was used for the property specific variables. A translog specification was used for the independent variables and a Box-Cox transformed dependent variable. Tests were carried out to correct for heteroscedasticity. The results indicate a statistically significant negative impact of 6.3 per cent to those properties adjacent to the HVOTL. The properties that are not directly adjacent were not affected, losing approximately 1 per cent.

The study by Hamilton & Schwann (1995) is a comprehensive analysis, which concentrates on the form of the distance variable. The sample data used covers four different neighbourhoods in the Vancouver area, and the authors provide no explanation of how they have combined or brought together the neighbourhood data into one set. Within the sample there are 2364 sales within 200 feet of the HVOTL and 426 were adjacent to the HVOTL. This is a good sample size taken over a six year timeframe. No mention is made of any adjustments for time or location, other than 'the time frame corresponds to a relatively stable period in the market place'. They find that 'neither the height of the transmission structures nor the voltage of the lines are found to be significant impact on property values. Other neighbourhood factors dominate the explanation of variations in property values' (Hamilton & Schwann 1995 pg 439).

Kinnard (1998) carried out a study looking at alternative sites within the USA for the siting of a new HVOTL corridor and also comparable existing lines over six counties. The HVOTL in this case is a single 765kv line and corridor. The study involved 509 transactions (160 residential 'improved' property sales and 349 vacant land sales) after removing outliers. The data set was separated into three sub-sets: by County, by distance zone, and by visibility of the HVOTL from the property. The distance is split into six concentric circles as follows: 1-100 feet, 100-200 feet, 200-400 feet, 400-800 feet, 800-1320 feet, and 1320-2640 feet. A dummy variable is used for both the distance and visibility, in the alternative model. The base model uses distance in feet as a measurement. The vacant land sales subset was divided into two pairs of sub-sets: the first pair being 10 acres or less, and over 10 acres; and the second pair being 20 acres or less, and over 20 acres. It is not indicated in the report how far back the sales go. However, from the results the sales appear to go back ten years to 1988. The dependent variables are Sales Price and Sales Price per Square Foot of Living Area, or on vacant land it is Sales Price per Acre. The results have a high coefficient of multiple determination (adjusted R^2) of .80 or higher using the Sales Price as the dependent variable. However, this drops when Sales Price per Square Foot of Living Area is used. The natural logarithm of sales price has also been used with a resulting lower R^2. The variables used in the base model for improved residential sales are comprehensive and displayed in the following table as follows:

- Distance from road frontage to HVOTL
- Subdivision (dummy)
- No road frontage (dummy)
- Difficult access (dummy)
- State road frontage (dummy)
- Mobile Home (dummy)
- Lot size
- Square feet of living area

- 1 storey (dummy)
- Number of bathrooms
- Age at sale
- Year of sale (dummy)
- County (dummy variable split into 6 counties).

The data for the counties were joined together into one database to obtain sufficient degrees of freedom.

The alternative model used, in addition to the above, included variables for distance (concentric circles) and visibility. The results show ‘there is no systematic pattern of negative price impact associated with being anywhere within a quarter mile distance from the centreline of either 765kv line in the study area’. This conclusion is carried through to the results for whether the HVOTL is visible or not. This study adds to the previous studies in that a visibility variable is added.

DesRosiers (1998) carried out a study using a sample of 507 residential properties in Montreal, Canada over a five year sales period. The study area contains three residential neighbourhoods bounded by major highways with a 315kv HVOTL running through the centre. The distance variable is calculated using both concentric circles and continuous distance. A visual variable is also used within the model. These results cannot be compared to New Zealand as the HVOTL runs along an easement, which is 200 feet wide. A previous study undertaken by DesRosiers uses a 400-foot wide easement. The results show that living next to the easement can in fact produce positive results as residents have an open view and have use of the easement. In this study the pylons used are the ‘Improved Visual Appearance’ conical steel pylons. The results of the research show that for properties that are not adjacent but have a direct view of a pylon there is a negative effect of 10%. A direct view of the transmission lines may reduce property values by between 5% and 10%.

A follow up study on the same area was undertaken by Wolverton & Bottemiller (2003) using paired sale methodology. Their findings confirmed the earlier work of DesRosiers where proximity did not affect the value, but a view of either the conductors or pylons had a negative effect.

One of the most comprehensive studies undertaken was by Ignelzi & Priestley (1991) for Southern California Edison Environmental Affairs. This study looked at eight neighbourhoods in California, which had varying treatment of the HVOTLs. Two areas had no HVOTLs, two had 115kv lines, one had a 230kv line, three had lines that had been upgraded from 115kv to include a 230kv line. Most areas have a 100 feet right of way easement, and some of the areas had the easement integrated into the neighbourhood, which provides a positive amenity with wide open spaces, and landscaping.

The results of the study found a positive effect of up to 10% for properties adjacent to the HVOTLs where the right of way (ROW) provided a positive amenity. The properties that showed an adverse effect were in areas where the ROW passed through private properties, thereby reducing their lot size and the associated value.

The findings offer several clear suggestions on ways Planners can mitigate or eliminate impacts before development begins. These include:

- ‘Avoid running any portion of the ROW through improved residential properties
- Integrate the ROW into neighbourhood with bike/walkways, landscaping, and the like
- Take care in modifying lines in developed neighbourhoods; gain community support at the outset.’ (Ignelzi & Priestley 1991).

The Ignelzi & Priestley study (1991) used multiple regression with the variables being input as continuous, logarithmic, or dummy variables. The distance variable was transformed to the reciprocal of the distance, which is the same model adopted by Callanan (1995, 2000).

Ignelzi & Priestley (1991) developed a methodology for assessing transmission line impacts on behalf of Edison Electric Institute, which aims to provide a standard for surveys and regression analysis. The analysis uses hypothetical data to create the model with the distance variable being constructed by four zones of concentric circles. As with other studies they suggest the regression model is composed of three types of variables:

- Neighbourhood and property specific variables
- Area wide economic factors
- Transmission line related measures.

For a survey of perceptions Ignelzi and Priestley suggest three questions should be addressed:

- 'Salience of the Line – to what extent is the line noticed by people living at varying distances from it and with varying views of it?
- Influence of Line features – what are the design siting and contextual factors that influence the visibility of the line?
- Line Effects on neighbourhood quality – how does the presence of transmission lines affect the residents evaluation of the overall environmental quality of their neighbourhood?'

While, for a survey of potential property value impacts they suggest the following four questions:

- Nature of the impact – has the transmission line construction adversely impacted the value of nearby residential properties? Is the impact all negative or are there benefits from the line?
- Size of the impact – how large are the effects in real dollar terms and/or as a percentage of the property value?

- Distribution of the impacts – how do the effects vary throughout the neighbourhood with distance from the line or view of the line, for example? Are properties adjoining the right of way affected differently than the others? Do the effects change over time?
- Effects of neighbourhood features – what are the features of the neighbourhood that influence the magnitude and distribution of the effects?

Priestley (1990) also undertook a study in Canada for Hydro-Quebec which analysed the economic feasibility of placing the HVOTLs underground, across waterways. He concluded that the feasibility 'depends on a variety of factors which are specific to the case and include:

- The sensitivity of the resource involved;
- The power, organisation and influence of those concerned with the resource;
- The regulatory context and the power and concerns of the regulatory agencies;
- The economic, analytic, legal, and political resources available to the utility.'

Kroll & Priestley (1992) summarised the main important points from recent studies as:

1. 'Overhead transmission lines have the potential to reduce the sales price of residential and agricultural properties.
2. The effect, especially for single family homes, is generally small (from zero to 10 percent) but has been estimated to be greater than 15 percent in some specialised cases in rural areas.
3. Other factors (e.g. neighbourhood factors, square footage, size of lot) are much more likely than overhead transmission lines to be major determinants of the sales prices of property.

4. Effects are most likely to occur to property crossed by or immediately next to the line, but some impacts have been measured at longer distances.
5. Positive impacts may also occur where the right of way is attractively landscaped and/or developed for recreational use.
6. Impacts may be greater for smaller properties than for larger properties
7. Impacts may be greatest immediately following construction of a new line (or a major increase in size in an older right of way), diminishing over time.'

Kroll & Priestley (1992) were generally critical of most Valuer (Appraiser) type studies because of the small number of properties included in the databases and the lack of econometric techniques used, such as multiple regression analysis.

Sims (2004) carried out a perception study based in the UK, along with an analysis of sales data from Scotland, which was applied to the case study in UK. The difficulty of obtaining reliable sales data in the UK provides a difficult platform to carry out an econometric analysis. However, in this study the professionals' perception is an average reduction in value of 10% to property values in close proximity to HVOTLs. This is a similar result to the New Zealand study by Bond and Hopkins (2000) where the Valuers and buyers reduced the property value by 10%. Sims & Dent (2005) note that developers in the 2000s are placing more low cost and social housing adjacent to HVOTLs. It is noted that in Kinnard's 1967 study it was observed that the USA was doing this from as early as 1960. Sims & Dent (2005) found that the studies that reported a negative reaction tend to suggest that it was not the health and safety issues but unsightliness, and visual and aural pollution. The comparison of means provided a 10-17.7% reduction for semi-detached property and a 6-13% reduction for detached property within 100m. The proximity to a pylon within 50m could reduce the value by 20%. The survey results demonstrated a negative reaction of between 5% and 10%. (Sims & Dent 2005)

Chalmers & Voorvaart (2009, 2012) carried out a study of 1200 sales in a ten year period over nine areas across Connecticut and Massachusetts. They measured the distance to the HVOTLs as both a continuous measurement and also concentric bands with sales taken from up to 2000ft (609m). The band widths used were 0-75m, 75-150m and more than 150m. The results show that it is the encumbrance of the transmission line easement that has a negative effect on the property value, rather than the proximity. They also conclude that there is not sufficient evidence to show any negative effects from the HVOTLs on property values. ‘Views’ of structures provided a positive impact, which was concluded to mean there was a positive value to having ‘long’ views. Callanan (1995) demonstrates the use of concentric bands reduces the accuracy of the regression equation as a property at 74m from the HVOTL may not have an effect and yet will be banded with sales in very close proximity, which may show an effect. The report also infers that the sales price was not adjusted for time, which over the ten year period is likely to be inaccurate.

The majority of studies undertaken have used either the sales comparison approach or regression analysis. However, in general it is very hard to identify closely comparable land sales. In the overseas studies it has been shown to be common practice by developers to make the lots close to the transmission line corridor bigger in size, which has offset any expected negative effect. This is not the case in the case-study research reported in this thesis, as the lot sizes vary across the whole neighbourhood according to the contour of the land.

Although the international studies are very useful in determining the methodology to be used, the New Zealand studies are unique to other countries that have been studied and published, in that the transmission lines transcend the top of the housing, and not over an easement or right of way adjacent to the property, as is the case in the United States of America and Canada. In the Newlands area (the case-study reported within this research) where the pylon is on a privately owned section, Transpower has existing use rights. Under the Resource Management Act 1991, for an existing use right to continue to be authorised, the effect of the use must remain the same or similar in character, intensity and scale. If the existing use was to be altered in any way there will be public input which might widen the compensation issue. Transpower has been attempting to obtain easements over private properties where it has been upgrading line voltage, and where it has been installing new HVOTLs.

The majority of transmission lines in New Zealand were installed prior to the 1980s, at a time when the public's perception of transmission line effects, their attitudes toward technology, their feelings regarding their social and legal rights, and their willingness to accept biological and environmental risks were quite different from today's perceptions

2.7.3 HVOTLs – perception/attitudinal studies

The number of attitudinal studies carried out is well in excess of the number of quantitative studies relating to the effects of HVOTLs on property values. This is largely due to the unavailability of complete data sets in some countries. The majority of the studies survey current residents or Real Estate Agents and property Valuers who overwhelmingly agree that there is a drop in value living close to a NIMBY. However, attitudinal and quantitative studies carried out on the same neighbourhood (Bond & Hopkins 2000) show a disparity between what is said and what actually happens. It is important to survey residents to determine if there was a free choice and whether all the facts were available in order for the purchaser to make an informed decision. It is also noted that residents tend to discount the value to a greater extent than property professionals do. Valuers who do not specialise in the area tend to discount the properties to a greater extent than Valuers who are specialists in this area.

A perception survey of HVOTLs undertaken in Tennessee by Kung & Seagle (1992) produced surprising results, with no respondents considering the HVOTLs as a possible health hazard, yet 87% replied that had they believed there was a possible health effect then this would have impacted on the price they paid for the property. The survey consisted of a very small sample size with 47 responses. Since the time of this study, the state has instigated laws that require sellers to disclose any sources of potential hazards to health and safety. I am not aware of any follow up study by Kung & Seagle since this change was introduced.

Mitteness & Mooney (1998) surveyed Buyers, Sellers and Appraisers in Minnesota USA, achieving 190 respondents. The results of this survey provide for a longer marketing time for those properties closer to the HVOTLs. Respondents indicated a reduction in property value of between 3.3% and 7.6%.

The attitudinal study undertaken by Pitts & Jackson (2007) surveyed Realtors and Appraisers within several central California areas. They do not disclose whether the professionals surveyed usually dealt with properties in close proximity to HVOTLs. The results of this survey were divided with half the respondents observing no negative impacts on either price or number of days on the market. The remaining half observed a negative impact of between 2% and 7% for homes that are either adjacent or have a direct view. They also advised an increase of up to 60 days on the market for these homes. For those properties without a view of the HVOTLs, there was no impact observed.

One of the Realtors from the Pitts & Jackson (2007) study who is active in the area noted ‘the negative effects from the power line are evident in a slow market. When demand is strong these effects diminish. The price effect depends on property characteristics and market conditions’. Another Realtor backed up this statement saying: ‘In a slow market, homes adjacent to a power line are harder to sell. These homes are great investment opportunities in a slow market, because any price effects diminish and may disappear when the market picks up.’

The findings in Pitts & Jackson (2007) contradict earlier studies by Kinnard et al (1994) and Delaney & Timmons (1992) which conclude that respondents who had no experience in appraising HVOTLs estimated much larger negative price impacts than did designated residential Appraisers experienced in valuing such properties. The Kinnard study (1994) analysed more than 700 sales in conjunction with a survey of local Appraisers, Realtors and owners. The results found that opinions of the ‘professionals’ were a lot more negative than the owners, and both groups were more negative than the actual sales data indicated. Kinnard (1994) concluded, ‘the literature of opinion research indicates that respondents commonly do not behave in the way that they say they would, when confronted with an actual purchase or sale decision, instead of a hypothetical choice.’

An international working group was established in 1993 called the International Electric Transmission Perception Project, with the head of this group being Mary Deming (1993) of the Southern California Edison Company. The research was set up to examine public perceptions of HVOTLs and substations. The products of the research will be a standardised research instrument, and guidelines for facility planning and impact assessment. The survey research instruments will provide respondents perception of:

1. EMF issues,
2. aesthetic issues,
3. property value issues.

The results of this research have not been published and appear to have been placed on hold.

A variation of the above studies was undertaken by Jayne (1997) and Gallimore & Jayne (1998) in which surveys asked buyers and Valuers to rank a list of twelve ‘everyday’ risks including HVOTLs. The top ranking risks in order for both groups were smoking cigarettes, and driving down a motorway in the rush hour. Valuers then ranked HVOTLs as number 3, while the Public ranked HVOTLs as 4, following drinking alcohol. These studies provide support for the developing theory that Valuers, or ‘professionals’, perceive the risks from HVOTLs at a higher level or impact than the general market does, and that Valuers who specialise in the areas where there are HVOTLs have a higher negative view than Valuers who are not familiar with the area.

This theory has been further tested by Delaney & Timmons (1992) who carried out a survey of Appraisers with 219 respondents, over eight regions. The survey asked participants to rank a list of perceived everyday risks with HVOTLs. Visual unattractiveness ranked as the highest, followed by health, noise and then safety. There was also an implication that the effect is a one-off negative impact, as once landscaping is established the HVOTLs would not be visible within the areas surveyed. It was also noted that the Appraisers who rarely valued properties close to HVOTLs reduced value to a greater extent than those that regularly worked in this area. 84% of respondents believed the HVOTLs negatively affected residential property values, with the mean decline being 10.2%.

2.7.4 HVOTLs near commercial or industrial zoned properties

The literature on studies that have used commercial or industrial zoned properties is very limited, with most studies being on residential property. A survey by Chapman (2005) was carried out over a number of different locations including northern California, Salt lake City and Las Vegas. All the properties surveyed were industrial and in areas where HVOTLs were a common sight. Any impact on value arose from zoning regulations, set back requirements and any easements which reduced the ability for the lot to be developed to its potential should the HVOTLs not exist. There were no examples of lower rent or price because of health effects. Any reductions were due to the reduced lettable floor area.

2.7.5 Perception of health effects from HVOTLs

A study of the literature related to HVOTLs would not be complete without also considering the perception of health effects from HVOTLs. As has been established in the previous section, respondents to perception surveys always cite potential health effects as a factor in their concerns about living in close proximity to HVOTLs.

This section will provide a background to the technical aspects of the HVOTLs and the associated magnetic field.

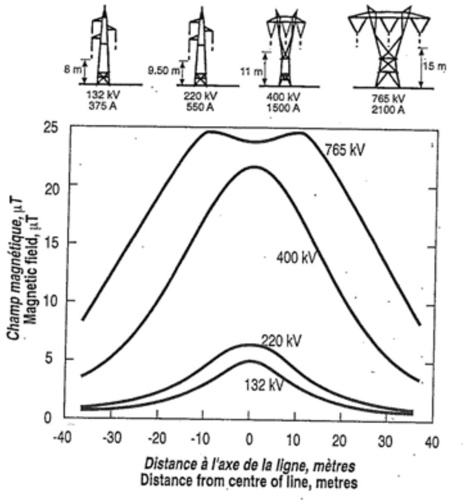
Magnetic fields are produced whenever there is a flow of electric current. ‘In addition to the magnetic field, the voltage on a current carrying wire or electrically charged surface produces an electric field around it. Both electric and magnetic fields are present around all wires carrying electricity, whether they are high voltage power lines, house wiring, or wires in domestic appliances. The strength of the electric field depends on the voltage, while the strength of the magnetic field depends on the size of the current carried (in amps). The strength of both fields reduces rapidly with distance from the wire’ (NZ Department of Health 1993). Most concern about potential health hazards has centred around HVOTLs.

There are two ways of transmitting an electrical current. In New Zealand, electricity is generally transmitted as an alternating current (AC). A direct current (DC) line is used for long distance transmission lines where the current flows in one direction. The only DC line in New Zealand is the Benmore-Haywards line which links the North and South Islands across the Cook Strait. A DC line has a much higher current of 250 KV upwards, whereas an AC line operates from 230 volts (normal household usage) to 220kv. The lines in the case-study are 110Kv AC lines.

Each conductor of a high voltage transmission line produces an electric field around it whose strength is related to the voltage. In the immediate vicinity of a high voltage transmission line conductor, the field strength is high enough to cause ionisation of the air and the formation of air ions, a process known as corona discharge. Air ions are groups of molecules with small electric charges. Some of the ions in the static field drop to the ground, thereby creating an ion current which effectively increases the total electric field beneath the line. The production and movement of ions is greatly influenced by weather conditions, particularly wind and rain.

The electric field under a power line is strongest in the middle of the spans, as illustrated in figure 2.1 below. The magnetic field decreases rapidly as one moves away from the line.

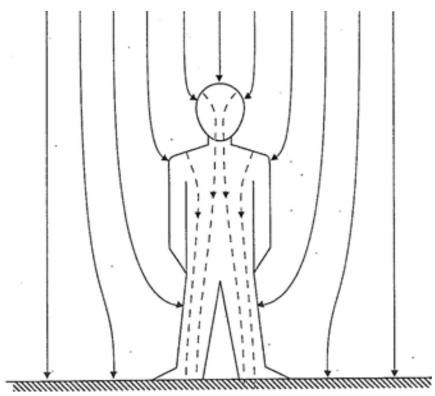
Figure 2-1 Magnetic field near the ground for some typical HVOTLs



Source: CIGRE (1993) Corona and Field effects pg 29

The current may be felt if the person touches another object in the electric field, such as a car or truck. Occasionally the electric field itself can be felt. 'The principal action is that of electric forces acting on the surface of the body, particularly on fine hair. For people, the sensation is of superficial tickling, changing to a light prickling in stronger fields. The threshold field for perception of this effect varies greatly between individuals with the majority of people not being aware of any effect under most lines' (CIGRE 1993, p. 25).

Figure 2-2 Electric current on person in magnetic field



Source: CIGRE (1993) Corona and Field effects pg 25 fig 4.5

During the past 20 years, there has been increased public awareness of the possible health effects from electromagnetic fields. The Swedish study Floderus et al (1993) had worldwide publicity regarding the linkage between HVOTL electromagnetic fields and leukaemia and brain tumours. Researchers have since tried to separate reports regarding HVOTLs effects on property values to those conducted prior to 1993 and after 1993.

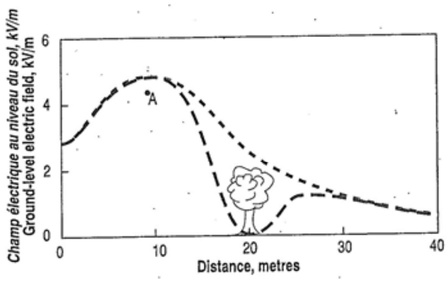
The National Research Council of the National Academy of Sciences in the USA released the findings of its review of research in October of 1996. Their report concludes: ‘Based on a comprehensive evaluation of published studies relating to the effects of power-frequency electric and magnetic fields on cells, tissues, and organisms (including humans), the conclusion of the committee is that the current body of evidence does not show that exposure to these fields presents a human-health hazard. Specifically, no conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer, adverse neurobiological effects, or reproductive and development effects’ (Stazer & Otto 1997 pg 32).

Cancerphobia is a term that that has issued from the significant New York court case of Criscuola v Power Authority of State of New York (592 N.Y.S 2d 79). In this case, the court awarded damages for future market value damages for a ‘perceived’ health risk associated with the electromagnetic fields from electric transmission lines. The court accepted that public perception was sufficient grounds. ‘We, of course do not hold that claimants are relieved from giving any proof to establish their claims and adjust compensation damages… Claimants should have to connect the market value diminution of the property to the particular fear in much the same manner that any other adverse market effects are shown.’ (Criscuola v Power Authority of State of New York (592 N.Y.S 2d 79))

The Electromagnetic Field (EMF) comes from ‘live’ conductors. ‘Ground level electric fields near an overhead line are mainly determined by the voltage of the line and how far away one is from the line. The conductor to round clearance and the conductor arrangement are also important factors, which have an effect on the electric field. Likewise, the conductor size and type (singled or bundled) may influence the ground level electric fields. Since the ground is a good conductor, the electric field at the ground is a good electrical conductor, the electric field at the ground is perpendicular to it and thus usually vertical' (CIGRE 1993 pg 25).

In its working group paper, CIGRE (1993) demonstrates the impact that screening has on the reduction of the spread of the EMF. The electric field is reduced in the vicinity of buildings, fences, vegetation, where the field is increased at the top and reduced down the sides of the screening (refer figure 2-3). This has the result of reducing the spread of the EMF and suggests that it would be beneficial to plant trees or high screening on the edge of any easement to reduce the spread of any potential EMF.

Figure 2-3 Ground level effect of magnetic field



Source CIGRE (1993) Corona and Field effects pg 25 fig 4.4

'Intense electric fields may occur at the surfaces of conductors and other "live" components of high-voltage systems. In some circumstances, this leads to ionisation and electrical breakdown of the air immediately surrounding the conductor. This effect is known as corona discharge, or simply "corona"' (CIGRE 1993). The presence of the Corona is a contributing factor to the crackling and humming noise that can be heard from HVOTLs. The other source of noise is from Aeolian, which is wind impinging on the different components of the line, conductors and/or isolators.

Various readings make reference to the perceived fear of health effects causing a loss in market value, rather than the actual health effects being compensated. Bryant & Epley (1998) refer to a court case heard in the Supreme Court of Kansas, Ryan v Kansas Power & Light Company, in which the court ruled: ‘In any condemnation case the objective is to compensate the landowner for damages actually suffered. Remote, speculative and conjectural damages are not to be considered; the owner cannot recover today for an injury to his child, which he fears, will happen tomorrow. Logic and fairness, however, dictate that any loss of market value proven with a reasonable degree of probability should be compensable, regardless of its source’ (Bryant 1998).

The court then went on to clarify: ‘In a condemnation action to acquire an easement for installation of a high voltage electrical line we find evidence of fear in the marketplace is admissible with respect to the value of property taken without proof of the reasonableness of the fear. Fear of a high voltage line is reasonable.’ The case of Criscuola v Power Authority of the State of New York further enforced the findings in the Ryan case, whereby it is not a personal fear that is compensable but the market perception of fear, which reduces the value. ‘The strength of an electric filed varies with the voltage of the transmission line, whereas that of the magnetic field relates to the current flowing in the conductor’ (Holland 1997).

A review paper prepared in 1993 by The National Radiation Laboratory, Department of Health, NZ (1993), was set up as a result of reports beginning in 1979 examining the relationship between exposure to EMF and incidence of cancer. During this review two reports were released, from Sweden (Floderis 1993) and one from Denmark (Olsen et al) in 1993, which produced worldwide publicity. They reported a statistically significant association between calculated field levels and childhood leukaemia. The Department of Health concluded that ‘when evaluated in the context of the existing large body of more than 60 epidemiologic investigations it remains the case that exposure to electromagnetic fields has not been demonstrated to cause cancer in humans.’ This paper was endorsed in 1997 by the research undertaken in the USA by the National Research Council and Committee of the Possible Effects of Electromagnetic Fields on Biologic Systems.

The Consumer institute in New Zealand undertook studies in 1994 to measure common Electromagnetic Fields (EMF) that are found around the house, including HVOTLs. The study was a reaction to reports and media interest at the time in the childhood cancer, suggesting that children living near HVOTLs are up to three times more likely to contract leukaemia. The study looks at different household appliances (computers, microwave ovens, electric blankets, clock radios, hair dryers, electric shavers) compared HVOTLs. The findings show a house 50 metres or more from HVOTLs will have normal EMF levels.

The perceived health effects are the subject of many studies and the majority conclude there is no direct associated health effect. Taubes (1994) sums up the findings of other reports as follows: ‘The big catch is that if electromagnetic fields have no detrimental biological effect, the absence of an effect will be impossible to prove. Outside mathematics, it is simply impossible scientifically to prove the non-existence of something. The best that science can do is to say that the existence of the phenomenon in question is highly unlikely and that the evidence in its favour is poor – which is what is being said today about EMF.’

The effect on Value arises from the perception of health effects; whether the health effect exists or not is not really relevant. If the potential buyers believe there is an effect, the price will be reduced and the pool of potential buyers will be reduced.

A report published by Anna (1989) states that between 1982 and 1986, 15 out of 17 surveys showed some link between cancer and electromagnetic fields exposure. Although none of the existing studies have proven conclusively the link between cancer and electromagnetic fields, implications do exist. In the USA there have been successful lawsuits resulting in expensive re-diversion of transmission lines.

A review by the National Radiological Protection Board (1992) in the United Kingdom concluded that: ‘the epidemiological findings that have been reviewed provide no firm evidence of the existence of a carcinogenic hazard from exposure to the extremely low frequency fields that might be associated with residences near major sources of electricity supply the use of electrical appliances or work in the electrical electronic and communications industries. Much of the evidence that has been cited is inconsistent, or derives from studies that have been inadequately controlled, and some are likely to have been distorted by bias against the reporting or publishing of negative results.’ This review along with individual studies has focused on the question of whether magnetic fields could cause or promote leukaemia or other cancers. There has been no change to this finding in more recent years.

In 2005, there was widespread media attention in Auckland, New Zealand, as a result of a study in which Dr Robin Smart found radiation levels to be ten times the accepted level in a suburb of Auckland where HVOTLs were present. There was also reported to be a cluster of leukaemia cases in children living in the area. Dr Smart attributed the presence of the HVOTLs to the creation of this cluster. New Zealand National Radiation Laboratory reported, at the time, that there was no research that linked the HVOTLs to cancer. As a consequence the media attention dropped off. However, there have been numerous studies over the years affirming a link and then others saying there is no link, which leaves the situation inconclusive.

2.7.6 Visual pollution of HVOTLs

Wolf (1998) reports on a 7 hectare power transformer site in Mexico, which was remote and attracting a lot of attention from vandals. The solution that was implemented was to lower the ground that the pylons were placed on by 3 metres and to use the fill to create a 5.5m berm. As a result, only the tops of the

HVOTLs were visible when viewed from outside the station. At 1.6km distance, the view disappeared altogether. Although this was done to stop vandalism (people were shooting out the isolators), this may also be an effective means for power distribution companies to consider for removing the visual pollution of the HVOTLs within urban areas.

The major power distributor in Finland has shown an increasing trend towards adopting artistic design elements, which hopefully will appeal to the public. ‘Using industrial design principles, main structural elements that can be mass produced are combined with visually appealing features to produce customised, artistic shapes. The designs are intended to avoid the monotonous repetition usually associated with transmission lines. Other key features of the design include vertical guys that can double as ladders, customised concrete bases and customised cross-arms, which, together with colour combinations create the desired artistic effects’ (Nieminen & Seppa 1996 pg 36). The design includes planting thousands of trees and shrubs along the easement to shield the visual impact. They also suggest painting the pylons and conductors green, which has been done successfully on a HVOTL in Austria.

2.8 COMPENSATION CASE LAW

2.8.1 New Zealand court cases

The New Zealand court cases related to the effect of transmission lines/pylons or substations is limited and predominantly related to compensation issues for the upgrade of a line, and the introduction of a new line.

The case of Lee v Minister of Works and Development was heard by the Land Valuation Tribunal, Christchurch in 1979. ‘The claimants owned a block of land in Christchurch and claimed compensation for loss arising out of the construction of a 220 kilovolt transmission line. They claimed injurious affection by the work because the market value of the land following the execution of the work was less than that immediately prior to the carrying out of the work and secondly it was not desirable or reasonable for the claimants to proceed with the building of a home on the land. The property was ultimately sold to an adjoining owner.' The decision held that the 'compensation for loss arising out of the construction of the public work was allowed. The claim for loss and damage by disturbance was disallowed. The statute did not permit separate assessment of damage done to retained land by acquiring authority other than by injurious affection unless damage that caused the value to depreciate was compensable. It must be damage to the property and not damage of a purely personal character.' Other cases related to compensation in regard to the erection of a transmission line are cited as Thompson v Minister of Works (unreported decision of the Auckland Land Valuation Committee, 17 September 1971) and Minister of Works v Scott and another (1967) NZLR 668. In both these cases compensation was awarded as damage to the property and not damage of a personal nature.

In the Minister of Works v Scott and another (1967) case, the respondent sought compensation to cover depreciation, inconvenience and loss of enjoyment due to the erection of a large pylon on land adjoining his land and of transmission lines traversing it. The Land Valuation Committee depreciated the value of the respondent's land and the Minister appealed. The damage complained of the presence of the power lines, noise and dripping water, and the distortion to radio and television signals. The appeal was disallowed.

The case of Todd v Minister of Electricity (1981), heard in the Land Valuation Court, Auckland, was in regard to compensation for the visual impact of a transmission line erected across a property. 'The claimants owned a rural block on Auckland's southern motorway and on which a distinctive award winning house was built. The Electricity Department passed a number of high tension power lines across the property at a distance of 140 metres from the house.' It was held that 'the only damage suffered by the claimants for whom compensation could be paid resulted from the visual impact of the transmission lines passing across the land. The detriment in relation to the property was of such small proportions that some method other than comparable sales evidence was needed to quantify it. Settlement figures as the basis of compensation also have to be treated with considerable care. In coming to a decision as to the quantum, it is relevant to take into account that the particular property was purchased and developed to provide a special example of rural living. It is more affected than a more modest or income producing property would have been.' Compensation was awarded.

The case of Haigh v North Canterbury Electric Power Board was heard in the High Court, Christchurch, on 5 September 1985, on appeal of the decision of the North Canterbury Land Valuation Tribunal on 21 March 1983. 'The appellant claimed against the Board for the erection of five power poles and electricity transmission lines installed by the respondent across the appellant's land. Both parties obtained valuations. The appellant subsequently sold the land for a sum much in excess of the valuations given six months earlier. The Tribunal held that the appellant had suffered no loss as any loss must have been absorbed in the purchase price.' The issue before the Tribunal was what the diminution in value of the land at the time the work was committed. The appeal was allowed and compensation paid to the appellant. Compound interest was paid on the sum at the rate of 10 per cent in satisfaction of the diminution of the value of the money and the loss of the use of the money.' This was in line with the decision made by the Court of Appeal in Drower v Minister of Works and Development (1984 NZLR 26).

2.8.2 Australian case law

The Australian case law is predominantly around the taking of land for the development or expansion of HVOTLs.

The courts have not assumed the acceptance of any single method for assessing the compensation payable for land being taken, of easements or right of way for HVOTLs. Each case has different circumstances and in a couple of the more prominent cases there are other variables that impact on the ability for the land in question to be developed. Ironhill Pty Ltd v Transgrid Ironhill Management Pty Limited v Transgrid (2004 NSWLEC 700), sought compensation for the taking of an easement over the property to construct a HVOTL. The property was used predominantly as a golf course and had been designed with the future taking of the easement in mind. There was also the issue that the area of land was subject to bushfires and was a Koala habitat, and therefore was highly unlikely to get development approval. The compensation value was calculated by using the ‘before’ and ‘after’ values.

The same method was used in the case by Kameel Pty Ltd v SPI Electricity Pty Ltd (Land Valuation) (2006 VCAT 1479) in which compensation was sought for the compulsory acquisition of easement for erecting a new HVOTL. In this case, transmission lines already affected the property. The courts accepted the ‘before’ and ‘after’ method in this case, while dismissing the alternative methods proposed by Valuers of a ‘depreciation based on the number of cables’ and also an ‘impact on the view line’.

The development potential of the site is assessed providing the development is capable of being approved, should the easement not be in place. Calculating how much the compensation is worth in lost land revenue can then assess the lost land area value.

2.9 METHODOLOGIES USED TO ANALYSE DATA

Now that we have looked at the different types of stigma and the impacts that these might create, this chapter turns to reviewing the methodology used in the previously discussed studies to ascertain the most appropriate methodology to use for this research.

The methodology that Ignelzi & Priestley (1991) developed through their international studies is regression based. At the time, they were endeavouring to develop a model that could be used to standardise studies worldwide. To standardise studies, as many characteristics on the house and section should be obtained as possible. These should include:

- The character of the view from the property
- Whether the nearby transmission line is visible, and the number of towers that could be seen
- Whether more distant transmission lines are visible and whether their towers were skylines or viewed against backdrops
- Height of towers
- Voltage of transmission line
- The typography of the land
- Relationship of the property to the transmission line
- Neighbourhood and property-specific variables
- Vegetation or landscaping of the area
- Housing type e.g. suburban single family home
- Housing characteristics.

Within the literature for the statistical analysis of the property sales, the most common methods have been the multiple regression analysis, comparison of means (or averages) and paired data analysis. Most researchers have used multiple regression as the preferred tool, as paired data requires a large database and for the sales to be paired in every respect, which can be difficult to achieve. Lipscomb and Gray (1995) use both techniques on the same data sets to try to understand the differences. Their conclusion: ‘multiple regression analysis [MRA] does well when many observations are available. The ability of MRA to use large data sets reduces the standard error of the coefficient estimates. This is offset by the potential introduction of bias due to model specification error and outlying data. And finally, the MRA process provides a purely market derived solution for adjustment values. Paired Data Analysis can be employed when a sufficient number of paired sales is available.'

The use of paired data is highlighted by Lipscomb & Gray (1990) with the difficulty in obtaining matched sales that are identical except for the factor being analysed. A difficulty arises in analysing the sales when most sales prices are very dependent on the negotiating skills of both the vendor and the purchaser. Therefore, this technique requires careful analysis of the background to each sale, along with a large database.

Kinnard & Dickey (1995) have identified three possible effects on market value. These can be identified on their own or as a combination of the following:

1. Diminished Price. Prices are compared with prices from a control area and diminished price is identified.
2. Increased Marketing Time. An increase in marketing time will mean a loss to the vendor as the holding costs and duration is extended.
3. Decreased Sales Volume. If buyers choose not to purchase close to the NIMBY through fear of the effect of the NIMBY or confirmed depreciation then fewer buyers will want to purchase and therefore prices will be driven down.

Kinnard & Dickey (1995) also identify three procedures for measuring any change in the market value as compared to a control area. These are:

1. Paired Sales Analysis
2. Survey Research
3. Market impact studies using multiple regression analysis (MRA) in the Hedonic pricing model format. In order to carry out a MRA the event has to have occurred so that a before and after analysis can be performed.

To carry out a reliable analysis, sampling bias and sampling error have to be minimised or eliminated. Hanley et al (1997) recognise three sets of characteristics to be used in a Hedonic Pricing Model when examining an environmental effect: Site characteristics (such as number of bedrooms, land area, condition); neighbourhood characteristics (such as distance from work, schools); and environmental characteristics (such as air quality, noise levels, contamination).

The studies to date, relating to measuring the effect of a NIMBY on property values, have used site characteristics plus an incomplete list of neighbourhood characteristics, with the emphasis being placed on where in the neighbourhood the properties being studied were placed rather than distance to work, schools and amenities. Environmental characteristics have been limited to 'distance' to the NIMBY, rather than incorporating the amenity of the neighbourhood. Visibility of the NIMBY is a key issue that has been ignored in the majority of studies to date. Studies have concentrated on physical distance from the NIMBY rather than visual impact. Incorporating a variable or visibility requires extensive fieldwork and will make the final equation and findings more robust. Linneman (1980) found that neighbourhood specific traits are important determinants of a sites valuation, explaining 15% to 50% of the standardised variation in valuations and inducing differential valuations as large as 100 per cent between structurally identical sites.

A repeat sales analysis was carried out by Palmquist (1982) to analyse the introduction of a highway on property values. Sales were collected over an 18 year period. After allowing for any non-market sales, there were 418 properties with at least two sales over the period, which allowed for the repeat sales analysis to be completed. The repeat sales method was chosen over hedonic methods because of the large number of variables that are required for each sale under hedonic methods. By using the repeat sales method, the characteristics of the property remain the same with the only changes being in the property age and the environment change applicable to specific location. The problem with using the repeat sales method is that there must be a significant number of properties sold at least twice over the study period.

However, repeat sales analysis has had increasing recognition within the valuation of environmental impacts over more recent times. (Lim & Pavlou 2007, Leichman & Watkins 2002).

As one of the problems currently faced is obtaining a large enough databases in close proximity to the NIMBY, having to obtain repeat sales in the study area will be very difficult. To perform a repeat sales analysis, other characteristics of the property must have remained constant over the period. The reliability of the results from a repeat sales analysis is reduced if there is a high level of collinearity between the independent variables.

There have been an increasing number of studies carried out looking at air, water, visual and noise pollution impacts on residential property values. The studies that have been undertaken have used Multiple Regression Analysis with a variety of data transformations. The size of the database has varied in the studies with one of the largest being by Thayer et al (1992) that used a data set of 2323 observations in Baltimore City. The journal article does not say how many of these observations were in close proximity to the NIMBY (in this case a rubbish dump). A linear and semi-log function was used which achieved very similar results. The study used concentric circles (zones) to measure the distance and then allocated dummy variables to each zone. The problem with this method is that the effect will be felt at a much higher level, the closer the sale is to the NIMBY. The concentric circles method is not an appropriate measure because to determine the gap between the circles you will need to know at what point the effect diminishes, and the effect is likely to be lost within the first concentric circle. The article is missing a lot of essential data to make a clear assessment of the point at which the effect diminishes.

Reichert (1999) responds to the criticism of using hedonic modelling for evaluating environmental damages, emphasising the correct use of variable selection, sample size, and the importance of sample size, and the importance of the control area selection. Reichert suggests the correct sample size for a regression with 15 independent variables (which is the approximate number used by most researchers) should be around 480 observations. Little benefit is added to the equation if the sample size is more than 500, with the risk of multi-collinearity increasing. Reichert's conclusion is that, although the ranking of the variables may change from one study to another, the important variables are constant, being house size, number of bedrooms, bathrooms and age. The control area should be selected to ensure that the major difference between the control and the study area is the environmental damage being assessed. A buffer area between the control and study properties should be maintained in order to clearly delineate the effect.

2.10 VARIABLE TRANSFORMATIONS

The Canadian study by DesRosiers (1998) uses both linear and log-linear functional forms in a standard and stepwise regression. DesRosiers tests several transformations for the distance variables: logarithmic, square root, inverse, quadratic and gamma.

'The analysis is first performed using the global sample. The market is then segmented and the east and west areas, the three distinct residential neighbourhoods as well as the lower and upper price sub markets are considered alternatively' (DesRosiers 1998 pg 3).

Reichert (1997) uses the following Cobb-Douglas exponential log linear function to study the effect of a toxic waste site.

$$\mathit{In}\mathrm{P} = b_o + b_1(\mathit{In}X_1) + b_2(\mathit{In}X_2) + \ldots\ b_n(\mathit{IN}X_n) + a_oD_o + \ldots + a_md_m + e$$

Where:

P	is the nominal selling price,
$X_1..X_n$	represents a series of continuous housing characteristics such as, square footage of living space, age, lot size etc.
$D_0..D_m$	represents various categorical (dummy) variables such as style, air conditioning etc.
B, a	represents the estimated regression coefficients on the continuous and categorical variables, respectively.
e	represents a random error term

In Reichert's (1997) study, the distance from the site is expressed as a dummy variable using concentric circles of four bands. The fourth band takes in properties 6751 to 9000 feet from the site. A continuous trend-shift model is used to test the robustness of the findings. 'The structural and locational variables in the continuous trend-shift model are identified to those used in the discrete time-space model'. The primary difference relates to the manner in which impacts are modelled. Instead of using a series of annual dummy variables this model estimates any significant changes in the price-distance gradient function within the study area. More specifically, the following variables are added to the model:

- A continuous time trend variable in natural log form replaces the individual annual dummy variables.
- A dummy variable divides the entire time period into before and after.
- A trend-shift variable, which allows the trend rate of appreciation in housing, prices to change during the pollution period.
- A continuous measure of the distance of each property to the most distant boundary of the study area which lies 9000 feet from the site.'

Colwell et al (2000) used a type of event study, in which time and space is incorporated. The announcement date of the event is taken as year 0. 'Dummy variables are incorporated into both the intercept term and slope. The former allows detection of price differentials at the announcement date across neighbourhoods, while the latter handles different rates of appreciation across neighbourhoods.’ Colwell et al (2000) use this model to replicate a number of studies undertaken previously, which have shown no effect. They conclude that this model allows the impact of the siting of a group home to be revealed.

Colwell et al (1997) concluded that land prices are nonlinear and concave in nature. This has an impact on the measurement variable within any Regression analysis. The Colwell study predominantly was analysing urban land development land sales and their lot size in relation to distance. As developers tend to increase land size for properties in close proximity to a HVOTL, Their conclusions can be applied to this study. The conclusion recognises that although land prices are non-linear, size greatly diminishing the effect of distance, this effect is not eliminated. This again highlights the importance of allowing for lot size variations within any model estimation.

2.11 CONTINGENT VALUATION – WILLINGNESS TO PAY

Traditionally, Valuers have used one (or a mixture) of three well-accepted methods to value properties. These methods are: sales comparison, cost, and income capitalisation. The regression analysis is also used by researchers of property values, and by government agencies, in carrying out mass valuations to set rating values. Contingent Valuation is an alternative method that has been used predominantly in the valuation of environmental impacts.

Contingent Valuation uses a survey to determine what respondents are ‘willing to pay’, or ‘willing to accept’ in payment, to either remove an environmental effect or accept an effect into their neighbourhood.

Pearce & Turner (1990) suggest that to examine the negative effect of damage caused by an environmental project is to measure the total economic value lost.

They used the following rule to determine whether a development is acceptable or not:

$(B_D – C_D – B_P) > 0$ to proceed

$(B_D – C_D – B_P) < 0$ not to proceed

Where:

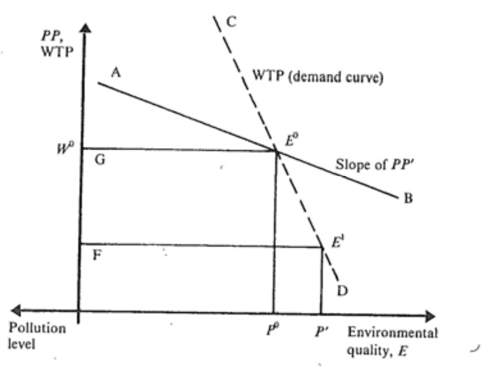
B_D refers to the benefits of the development.

C_D refers to the costs associated with the development.

B_P refers to the benefits of preserving the status quo of the area.

It is the last variable, the benefits of preserving status quo, that is the hardest to measure. Pearce & Turner (1990) carry the equation a step further by trying to measure each household's 'willingness to pay'. To do this, a demand curve is created. Willingness to pay is then extended to see the effect of variation in household income and other household characteristics, as illustrated in figure 2-1

Figure 2-4 Willingness to pay and hedonic property prices



Source: Pearce & Turner 1990 Fig 10.2, pg 146

The willingness to pay method can be combined with a survey using a hypothetical neighbourhood. Pearce & Turner (1990) suggest a bidding process, where the surveyor suggests the first bid, as a starting point. The starting point is then increased or decreased accordingly, to a point where the respondent would be willing to pay, or willing to accept the development. Bias may be introduced to the survey through the surveyor setting the opening bid. The other source of bias would be if there was a difference between the hypothetical market and the actual market. The assumption has to be made that the hypothetical market is the same as the actual market. A third source of bias can arise from the respondents not wishing to reveal the truth in case it is in some way disadvantages them.

An assumption is made that people are prepared to put more weight on any loss of property value, than a similar sized gain.

A study by Brookshire et al (1981) used a willingness to pay study in southern California to determine whether households pay more for cleaner air through higher property values. The study used two separate approaches. 'The first approach involves a comparison of average housing values in pairs of communities, standardising only for house size. The second approach uses a multistep econometric procedure, which allows air pollution abatement to be valued differently by households'

The hedonic price function is a commonly used method applied to environmental valuation. 'First, a hedonic price function is estimated: second, implicit prices are calculated for the environmental variable of interest: third, a demand curve for this variable may be estimated' (Hanley 1997). Each one of these steps holds problems for the analyst.

Freeman (1982) examines the theory of the willingness to pay (WTP) and the willingness to accept (WTA) principle. WTP is the amount of money loss that would just offset the gain in utility due to moving to situation B. One of the constraints of this principle is that an owner is going to base their WTP figure on the constraints of their income, rather than the true value of the utility gained. 'The definition of benefits as willingness to pay implies the existence of a demand curve for the effects of the environmental improvement' (Freeman 1982). Freeman cites a study by Randal et al (1974) that deals with aesthetic impacts of a power plant including air pollution, effects of landscape and visual impact of the transmission lines. 'Respondents indicated an average bid per household of $50 per year to move to a somewhat improved aesthetic state and an additional $85 per year to go beyond that to a substantially improved state.' There is no indication within the paper as to how the respondents were to pay the money, or the options that they were presented with.

Callanan (2010, 2013) carried out a detailed study in Auckland New Zealand, where a Contingent Valuation approach was used in conjunction with a hedonic pricing model. The results show an anomaly between the Contingent valuation approach and how much residents are willing to Pay to have a HVOTL removed. This is in contrast to the hedonic pricing model for the same area, which shows that the HVOTLs have a negative impact on property values. In this study, a willingness to pay survey was posted to 887 owner occupied properties, with a further 50 properties being visited and a face-to-face survey was carried out.

The study combined both a regression analysis to determine house price impacts, along with a willingness to pay survey. The survey included a number of questions, with the main one asking how much the residents would be prepared to pay to have the HVOTLs removed. The options provided included; a one off payment based on capital gains at the time of sale; a monthly payment against their power bill; or an annual payment on their Council rates bill.

Other questions were added by the power supply company to gauge a better understanding of consumers' preferences about the visual appearance of the towers. The results from those questions show that consumers would prefer not to have the towers lifted in height, and also a preference for a slimline tower rather than the lattice tower.

Results show that for the majority of respondents, the affordability of the presence of the transmission lines was not an important feature in their decision to purchase the property they now live in.

The majority of respondents (approximately 70%) considered that the transmission lines and towers have an impact on their property values. In a separate question 60% believed the removal of all the towers and lines would increase their property value by around 10% of what they consider to be the current market value. The remaining 40% believed the removal of the lines would have no impact. Of the total respondents, 74% did not feel that reducing the multiple sets of lines to a single set would increase their property value.

The analysis of actual sales in the areas showed that the effect of having either a tower or transmission line close to a property is significant and has a negative effect of approximately 20% under the lines or adjacent to the tower, decreasing to 5% at fifty metres. This effect diminishes to a negligible amount after 100 metres. However, the perception of residents was that the presence of the towers and lines reduces their property values by around 10%.

The majority of respondents strongly opposed (80% of respondents) any form of contribution by themselves towards the costs of removing the transmission lines and towers, and of those that were willing to pay, the least opposed option was a percentage of capital gains on the sale of their property. However the sales analysis confirmed that a discount of around 15% per cent had been paid for the property being in close proximity to the HVOTLs, and yet the residents were not prepared to pay anything to regain the 15% loss.

The combined postal survey and face-to-face surveys provided a high level of comments and feedback. In summary, the negative impacts that repeatedly appeared were the following:

- Towers and lines are ugly
- Lines are noisy
- Lines create interference with television and radio reception
- Fear of health problems created by presence of lines.

There was a small number of respondents who reported a positive impact of having the towers and lines in the area, in regards to the properties being cheaper to purchase.

One of the limitations that was outlined by Callanan (2010) is in regards to setting the level of the starting bids. This limitation was backed up by Lipscomb (2011) who also experienced a property with respondents starting their bid very low and also exhibiting strategic behaviour in their replies.

A question that was raised within Callanan (2010) study is in regards to the appearance of the HVOTLs and whether altering their appearance may produce a reduction in the stigma attached to them.

Chapter 3: Research Design

In the previous chapter, a critical analysis of the literature was carried out, which summarised the literature to date concerning the following main areas: Not In My Back Yard syndrome, stigma, valuation methodology, and High Voltage Transmission Lines.

In this chapter, the methodology is outlined for using a regression analysis and also a repeat sales analysis. These are the two methods predominantly used for the research reported in this thesis. To better understand the importance and shortcomings within the valuation process of valuing NIMBYs and stigma, the current valuation techniques in valuing the impact of an undesirable structure within a residential area will be outlined.

3.1 CURRENT VALUATION TECHNIQUES

3.1.1 New Zealand practice

The technique widely used by the Valuation industry in New Zealand to deal with a NIMBY in a residential neighbourhood is to use the sales comparison approach, and make a plus or minus percentage adjustment. This adjustment is based on the Valuer's subjective opinion and is not a uniform amount. The Valuer's individual beliefs therefore have a direct effect on value. In a study by Delaney and Timmons (1992), it was found that Valuers without any experience in valuing properties near a NIMBY presumed and estimated a larger negative price effect than did experienced Valuers.

In 1984, the New Zealand Department of Valuation provided a report, which outlined the basis for the valuation of properties in proximity to a HVOTL. The report used a sales index approach to determine whether there was an effect, with a very small sample size of 30 properties over 18 locations. The results showed a loss for the affected properties of between 0% and 15%. The guidance notes from this report are still used. However, they are no longer of much benefit as the report was published in 1984, well before the release of the Floderus (1993) report on the Swedish study on health effects associated with proximity to HVOTLs, which raised public concerns about living in close proximity to HVOTLs.

Valuers within New Zealand have historically used a standard 10% negative adjustment factor for properties that are in close proximity to HVOTLs (Gibson 1984). However, this basis is flawed as it is based on the historical report by the Department of Valuers (1984) and is applied ‘across the board’ with very limited rigour behind the calculation. The other main limitation to this approach is that there is no recognition of distance to the HVOTLs, or view of the towers. Therefore, this thesis should provide a better understanding to the Valuation profession of the impacts, and also a sound basis for applying the adjustments required within the valuation process.

In a document prepared by the New Zealand Ministry for the Environment, in partnership with the Ministry of Health (2000), national guidelines were established on managing the health effects of radiofrequency fields. The guidelines were incorporated into the 1999 New Zealand Radiofrequency fields exposure Standards. Although this document refers to the placement of radiofrequency transmitters, it highlights the key issues as being consultation, and public concern in relation to health issues. The Environment Court ruling on the Shirley Primary School v Telecom Mobile Communications Ltd (1999 NZRMA 66) provides guidance on many of the contentious issues in regard to the siting of telecommunication transmitters. ‘It found that a very low probability of potential health effect was not sufficient for denying a resource consent for siting a cell phone transmitter.' This ruling related to the issuing of a Resource Consent under the Resource Management Act, and not to an issue of compensation.

Jaconetty (1996) uses asbestos as an example of how the existence of a negligible health hazard was blown up to an extreme problem. If market participants believe a negative effect does exist then this will influence their behaviour and have a direct impact on the market. As the basis of residential property valuation is the sales comparison approach, the existence of sales based on 'fear' or 'stigma' is projected onto neighbouring property values. The term 'market value' is defined as the price on a specified date reached by a willing, fully informed, knowledgeable and not over anxious buyer and seller. If either party is not fully informed and knowledgeable regarding the NIMBY then the selling price cannot be described as market value and should not be used as a comparable sale within the sales comparison approach. This information is very hard for the Valuer to determine and therefore will be overlooked in the majority of cases. If the definition of 'market value' was strictly applied then every sale would need to be checked to determine whether the purchaser was 'fully informed and knowledgeable', particularly in a market where full disclosure by the vendor is not mandatory.

Guidance on the valuation of contaminated land for UK Valuers is contained in Guidance Note 2 of the RICS Appraisal and Valuation Manual 1995 and also in Contaminated Land: Guidance for Chartered Surveyors 1995 (RICS 1995). New Zealand Valuers also follow the RICS guidelines. The USA has adopted Guide Note 8 of the Standards of Professional Appraisal Practice of the Appraisal Institute (Appraisal Institute 1992). The interpretation of environmental forces includes social, economic and governmental factors. Value is determined to include hazardous substances, which are defined as 'any material within, around or near a property that may have a negative effect on its value'. Both the UK and USA guidelines are restricted to contamination or effects that can be remedied. There is no guidance within either the UK or USA guidelines for valuing ‘stigma’.

As HVOTLs in most countries are contained within easements, it is appropriate to also discuss easements and what their impact could be. An overview of easements and their effect on value is provided by Kellough (1993). This is a review based on easements in Canada, which are significantly wider than those found in New Zealand and Australia; however, the principles raised are applicable to all easements. Easements are divided into either a visual impact or a physical impact. HVOTLs clearly fall into the visual impact category; however, to a much lesser extent they also have a physical impact when maintenance works are required. Unlike a physical impact, establishing loss of value associated with visual impact is essentially a matter for judgement and of perception. Kellough (1993) ascertains that the impact is specific to each case as a property that is purchased to take advantage of a view across paddocks or to the sea will be impacted by the presence of HVOTLs to a greater extent than a property with no external view.

3.1.2 International perspective

When appraising the value of property, where an easement is taken for the purpose of a transmission line right of way, the most common method used by Valuers has been the ‘before and after’ valuation, where the difference between the two is the compensation payable, if any. Dempsey (1981) reports on the process that is accepted in Alabama, which he refers to as DUPA (Development Use Proximity Analysis). This technique is based on the premise that there are two types of loss:

1) Reduction in land available for development, and
2) The additional cost to develop the land.

If either of these two analyses produces a negative effect then this is regarded as the ‘impact’ or ‘compensation’. This technique applies the same principles a prudent Developer would adopt, where they would only pay the amount that is economic for development.

Chalmers & Jackson (1996) conclude that the best method for understanding and analysing effects of contamination (air, water, visual) is through the Income Capitalisation approach. This is contrary to the majority of studies for residential property, but would hold correct for any income producing property or where there is an established ‘clean-up’ cost involved. For the analysis of effects on HVOTLs this approach generally would not apply, unless it could be extended to the cost of removing the HVOTLs, which is generally cost prohibitive. Therefore, the Income Capitalisation approach has been discounted for this study.

In accordance with Haney (1992), the USA has tried to address the public’s environmental concerns with the introduction of the National Environmental Policy Act of 1969. The protection agency set up to administer and review the requirements of the Act, with the listed hazards as being:

- Stored hazardous or toxic materials
- Leaking underground storage tanks
- Contaminated water supplies from nearby landfills
- The use of lead or asbestos in building materials
- Airborne chemicals
- Dangerous levels of radon gas.

The list does not include the proximity of HVOTLs, nor natural disasters.

3.2 METHODOLOGY

Within the literature for the statistical analysis of property sales, the most common research methods have been Multiple Regression analysis, comparison of means (or averages), repeat sales and Paired Data Analysis. Most researchers in the property and real estate fields have used multiple regression as the preferred analysis tool.

Paired Data Analysis requires a large database and for the sales to be paired in every respect, which can be very difficult to achieve. Lipscomb & Gray (1995) use both techniques on the same data sets to try to understand the differences. They concluded that: 'Multiple Regression Analysis does well when many observations are available. The ability of Multiple Regression Analysis to use large data sets reduces the standard error of the coefficient estimates. This is offset by the potential introduction of bias due to model specification error and outlying data. And finally, the Multiple Regression Analysis process provides a purely market derived solution for adjustment values. Paired Data Analysis and Repeat sales can be employed when a sufficient number of paired or repeat sales are available.'

3.2.1 Hedonic pricing model

To carry out a reliable analysis, sampling bias and sampling error have to be minimised or eliminated. Hanley et al (1997) recognise three sets of characteristics to be used in a hedonic pricing model when examining an environmental effect: Site characteristics (such as number of bedrooms, size and land area); neighbourhood characteristics (such as distance from work, schools); and environmental characteristics (such as air quality, noise levels). The studies to date that measure the effect of a NIMBY on property values have used site characteristics plus an incomplete list of neighbourhood characteristics, with the emphasis being placed on where in the neighbourhood the subject was placed rather than distance to work, schools and amenities. Environmental characteristics have been limited to ‘distance’ to the NIMBY, rather than incorporating the amenity of the neighbourhood.

Visibility of the NIMBY is a key issue that has been ignored in the majority of studies to date. Studies have concentrated on physical distance from the NIMBY rather than visual impact. Incorporating a variable for visibility requires extensive fieldwork and will make the final equation and findings more robust. Linneman (1980) found that neighbourhood specific traits are important determinants of a sites valuation, explaining 15% to 50% of the standardised variation in valuations, and inducing differential valuations as large as 100% between structurally identical sites. However, introducing a variable for ‘visibility’ would help increase the reliability of the valuation.

3.2.2 Multiple Regression analysis

There have been an increasing number of studies that consider air, water, visual and noise pollution impacts on residential property values. The majority of studies undertaken have used Multiple Regression Analysis with a variety of data transformations. The size of the database has varied in the studies with one of the largest being by Thayer et al (1992), which used a data set of 2323 observations in Baltimore City. The journal article does not say how many of these observations were within close proximity to the NIMBY (in this case a rubbish dump). A linear and semi-log function was used which achieved very similar results. The study used concentric circles (zones) to measure the distance and then allocated dummy variables to each zone. The limitation with this method is that the effect will be felt at a much higher level, the closer the sale is to the NIMBY. The concentric circles method is not an appropriate measure because to determine the gap between the circles it is necessary to know at what point the effect diminishes, and the effect is likely to be lost within the first concentric circle. Thayer et al (1992) do not provide essential data which makes it difficult to draw a clear conclusion; however, they raise interesting issues that all researchers in this area need to be aware of. Therefore, the methodology applied within this thesis does not use the concentric circle method for the variable in determining the distance to the HVOTLs.

Reichert (1999) responds to the criticism of using hedonic modelling as evaluating environmental damages, emphasising the correct use of variable selection, sample size, and the importance of the control area selection. Reichert suggests the correct sample size for a regression with 15 independent variables (which is the approximate number used by most researchers) should be around 480 observations. Little benefit is added to the equation if the sample size is more than 500, with the risk of multi-collinearity increasing. Reichert's conclusion is that, although the ranking of the variables may change from one study area to another, the most important variables are house size (either number of bedrooms or bathrooms) and age. Reichert's (1999) study assumes that the 500 observations/cases are all significant in the equation outcome. However, in the case of HVOTLs, the impact is shown to be in close proximity. There may be only a small portion of the 500 observations that are in close proximity, and therefore a much larger sample size is required to get statistically significant results (Callanan & Hargreaves 1994).

The control area should be selected to ensure that the major difference between the control and the study area is the NIMBY or environmental damage being assessed. A buffer area between the control and study area should be maintained in order to clearly delineate the effect. The control area for this thesis will be detailed later in this chapter.

Multiple regression is the statistical analysis used to investigate the effects of one dependent variable, in this case the selling price, against a number of independent variables. An equation is produced which explains the relationship between the effect of the independent variables against the selling price. The objective of the regression analysis is to calculate the straight (Linear regression) line that best describes (or fits) the minimal scattering of the actual (Y) data points.

A number of different equations (using various variable transformations) were tried, to determine the best line of fit for calculating the dependent variables, and is set out as follows:

$$Y = a + b_1 x_1 + b_2 x_2 + b_3 x_3 + \ldots\ldots\ldots b_n x_n + E$$

Where Y = dependent variable

a = constant or Y intercept

b = coefficient or slope of the regression line

x = independent variable

E = the error term or residual value. This is the difference between the predicted and actual values for each case.

A weighted sum of the explanatory (independent) variables is found, so that the weighted sum is as highly correlated as possible with the values of the dependent variable.

There are several objectives to finding the relationship between the dependent and independent variables. They can be used to:

1. Analyse the effects of decisions that involve changing the individual independent variables

2. Forecast the value of a dependent Y variable for a given set of Xs

3. Examine whether any of the independent variables have a significant effect on the dependent variable.

Regression is based on the least squares method, which aims to minimise the sum of the differences from the predicted and actual values. The following assumptions must hold for this method to be accurate:

1. Normality and equality of Variance. The variance of Y (dependent variable) is the same over all values of Y, with a constant variance of sigma squared.

   To test for equality of variance a standardised scatterplot of the residuals, of actual values, is constructed. There should be no pattern apparent. If this is not the case, the estimates of standard errors will be inaccurate. This is known as heteroscedasticity.

2. There is a linear relationship between the independent variables and the dependent variable.

3. The sample is of sufficient size to allow for precision of the estimates. The precision of estimates can be seriously affected if the sample is too small, because the number of degrees of freedom is reduced by 1 for every independent variable.

4. The value of the independent variables must be statistically independent of each other (that is, not correlated).

5. The value of one independent variable must not depend on the value of another independent variable. Otherwise the independent variables are said to 'interact'.

This is the same method used by major USA studies commissioned by Edison Electric Institute, Southern California (Kroll & Priestley, 1991). A regression analysis can incorporate a large number of independent variables. This is beneficial in analysing a property market as there is a large number of factors that may influence sales price, including the impact of the transmission lines and pylons. Regression analysis is an approach that has been used to study property markets for more than four decades and it is well accepted in the literature. An explanation of the interpretation of output has been included in Appendix A.

3.2.3 Model specification

The model specification used to describe the changes in sale price and transmission line impacts consists of three different variables;

* Property specific variables
* Market factors
* Transmission line and pylon distance.

Reviews of published literature along with an understanding of the housing market in New Zealand have helped formulate the most appropriate variables to be used in the regression model. Due to the large number of variables that may come into a purchaser's decision, this list only contains those variables, which could be objectively determined, plus a subjective variable for view and condition, and has significant explanatory power. To produce the regression equation, three types of formulations were used:

- Continuous – The actual measurement was used without transformation.
- Dummy variable – Variable is either coded one (1) or zero (0). If it has the feature it has a 1, if not it has a 0.
- Transformed – The variable has had a transformation carried out on it.

Testing of the location and quality factors is performed through the use of dummy variables. A dummy variable is used to isolate and quantify effects of a definable condition or event. If the condition or occurrence applies to a property at the time it is sold, the dummy takes on the value one, indicating presence; otherwise it has a zero value and does not affect the sales price. In this equation, a dummy variable was initially tried for the transmission line effects. This was found to be inappropriate as it required the distances to be separated into bands and as the effect is sensitive when the properties are closer to the HVOTLs, the result was distorted. A more appropriate measure was found by using a continuous variable, which gave the reciprocal of the distance in metres. Any missing values were coded as 999999, and outliers were checked.

3.3 VARIABLE TRANSFORMATIONS TO MEASURE FOR NIMBYS

The main New Zealand study on HVOTLs by Callanan (1994, 1995), and the Canadian study by DesRosiers (1998), used linear and log-linear functional forms in a standard and stepwise regression, while testing several transformations for the distance variables: logarithmic, square root, inverse, quadratic and gamma. 'The analysis is first performed using the global sample. The market is then segmented and the east and west areas, the three distinct residential neighbourhoods as well as the lower and upper price sub markets are considered alternatively.' (DesRosiers 1998). The price segments are separated out and analysed individually

Reichert (1997) uses a Cobb-Douglas exponential log linear function to study the effect of a toxic waste site.

$$\mathit{In}P = b_o + b_1(\mathit{In}X_1) + b_2(\mathit{In}X_2) + \ldots. + b_n(\mathit{IN}X_n) + a_oD_o + \ldots + a_md_m + e$$

Where,

P	is the nominal selling price,
$X_1..X_n$	represents a series of continuous housing characteristics,
such	as, square footage of living space, age, lot size, etc.
$D_o..D_m$	represents various categorical (dummy) variables such as style, air conditioning etc.
B, a	represents the estimated regression coefficients on the continuous and categorical variables, respectively.
e	represents a random error term.

In Reichert's (1999) study, the distance from the site is expressed as a dummy variable using concentric circles of four bands. The fourth band takes in properties 6751 to 9000 feet from the site. A continuous trend-shift model is used to test the robustness of the findings. 'The structural and locational variables in the continuous trend-shift model are identical to those used in the discrete time-space model. The primary difference relates to the manner in which impacts are modelled. Instead of using a series of annual dummy variables this model estimates any significant changes in the price-distance gradient function within the study area. More specifically, the following variables are added to the model:

- A continuous time trend variable in natural log form replaces the individual annual dummy variables.
- A dummy variable divides the entire time period into before and after.
- A trend-shift variable, which allows the trend rate of appreciation in housing, prices to change during the pollution period.
- A continuous measure of the distance of each property to the most distant boundary of the study area which lies 9000 feet from the site.' (Reichert 1999)

An event study was used by Colwell et al (1999) where time and space is incorporated. The announcement date of the event is taken as year 0. 'Dummy variables are incorporated into both the intercept term and slope. The former allows detection of price differentials at the announcement date across neighbourhoods, while the latter handles different rates of appreciation across neighbourhoods.' (Colwell et al 1999) Colwell uses this model to replicate a number of studies undertaken previously, which have shown no effect. They conclude that this model allows the impact of the siting of a group home to be revealed.

Colwell et al (1999) concludes that land prices are nonlinear and concave in nature. This has an impact on the measurement variable within any Regression analysis. His study predominantly analysed urban land development land sales and their lot size in relation to distance. As developers tend to increase land size for those properties in close proximity to a HVOTL, his conclusions can be applied to this study. Colwell's conclusion recognises that although land prices are non-linear in size, greatly diminishing the effect of distance, this effect is not eliminated. This again highlights the importance of allowing for lot size variations within any model estimation.

Boyle & Kiel (2001) undertook a survey of studies on impacts of environmental externalities. They analyse a variety of studies with an emphasis on those that look at air and water quality or pollutants. This study is relevant as it also looks at the importance or otherwise of including neighbourhood variables and how these may impact on the results. The factors that they emphasise are the location of the house in relation to roads, and to transportation. It can be beneficial to live close to these, and they cite studies by Gatzlaff & Smith (1993), and Grass (1992) which report a positive effect by living close to a train station. However, Benjamin & Sirmans (1996), and Hughes Sirmans (1992) found that busy roads have a negative effect on house prices. Dubin & Goodman (1982) found that it was education facilities and crime that had an impact on the neighbourhood characteristics.

Which neighbourhood characteristics are included within the regression model may have an impact on the final equation, which may place more or less emphasis on the variable being analysed.

3.4 PAIRED DATA AND REPEAT SALES

A problem with using the repeat sales method is that there must be a significant number of properties sold at least twice over the study period. As one of the limitations is obtaining a large enough database in close proximity to the unwanted facility/structure, having to obtain repeat sales in the study area can be difficult. To perform a repeat sales analysis, other characteristics of the property must have remained constant over the period. The reliability of the results from a repeat sales analysis is reduced if there is a high level of collinearity between the independent variables.

To gain a better understanding of the data, variations that have occurred over time, and any trends, an analysis of the data is carried out.

The analysis of data examines the sales data including the following variables: sale price, land area in square metres, floor area in square metres, construction materials, number of bedrooms, length of time on the market, and the difference between list and sale price. This information has been obtained from two New Zealand property sales database sources: Headway NZ, and Real Estate Institute of NZ.

Demographic information was obtained using the census data from Statistics New Zealand (a NZ government agency) to gain an understanding of whether the demographics of the area have altered over time, particularly any trend away from what would be expected from any other area within New Zealand. This information is collected via a census survey, which is carried out every five years, with every person (including tourists) legally required to complete this information. The census collects information relating to people and dwellings.

3.5 REPEAT SALES ANALYSIS

The literature outlining the use and appropriateness of Repeat Sales was discussed in the previous chapter. In this chapter, the methodology and how it is applied in this research will be outlined.

Kilpatrick (2006) uses a Repeat sales analysis as the appropriate method for measuring the impact of an announcement of contamination on the housing market. By applying a repeat sales analysis, the property characteristics are maintained with the only difference from one sale to the next being the announcement of contamination. The Kilpatrick (2006), Reed (2011) and Eves (2004) reports provide the basis for using this method when an event occurs to enable the stigma to be isolated from the housing variables.

For the purpose of the research outlined in this thesis, the opposite impact is being analysed. The removal of a detrimental impact can be seen in the comparison as being the same as the introduction of an impact; in the Kilpatrick (2006) study this is an announcement of contamination, whereas for Eves (2004) and Reed (2011) this is a flood event. The expectation is that the opposite effect will occur – that the removal of the impact will create a positive impact, as compared to the negative impact from introducing an event.

To have confidence in the validity of the repeat sales index, the individual property variables must have stayed the same between one sale and the next. Within this thesis the repeat sales index is taken a step further by looking at each of the relevant repeat sales as individual case-studies to ensure that the property variables have not changed over the study period.

A further limitation noted within the Kilpatrick (2006) study is the dissemination of information to buyers. This would also be expected to be a factor within the studies examining natural disaster events. Kilpatrick refers to a report by Simons (2002) which outlines the problem as:

a) It will often take many years for the information to be disseminated throughout the market.
b) In the short term buyers have limited choice, which may result in disequilibrium of supply.
c) In short term, often sellers will have a minimum price they will sell for, given debts on the property, and therefore they will not proceed with the sale.

For the purpose of this thesis research, the above limitations do not apply as selling price is expected to increase, rather than decrease, as is the results of the natural disaster or contamination studies. In addition to this, buyers will be immediately aware of the removal of the HVOTLs as they are a very visible structure. However, the stigma may arise from potential buyers further afield who were previously aware of the HVOTLs presence and are not aware of their removal. Consequently they do not consider this area as a buying option for them.

3.6 SAMPLE SELECTION

The sample taken should be a representation of the population from which it is drawn. The sample must represent the characteristics of the population. If it is not representative then this may reflect bias.

There are a number of sampling techniques available. The method chosen will depend on type of research, cost of collecting data, or physical constraints. The method chosen for this research was a convenience sample. Although this method is not as good as a Simple Random Sample, there was limited data on recent sales prices available. The sample taken incorporates houses of varying age, size and construction.

The sample was developed using New Zealand Institute of Valuers Valpak-2 software distributed by Headway NZ, which has a record of all sales transactions. All residential Newlands sales were extracted for the 27 years period 1 January 1983 to 31 December 2010. To eliminate large changes in the market over time, and changing perceptions of transmission line effects on health, a timeframe of six years (31 December 1989 to 31 December 1995) was used for the period prior to the removal of the HVOTLs. Six years data produced 330 sales within three hundred metres of the transmission lines, which is enough to make the regression equation statistically reliable and to give confidence in the results.

Residential sales were then gathered for the period 1995-2010, being the period following the removal of the HVOTLs. For this period there were 3345 sales within three hundred metres of the lines.

For each sale the following variables were extracted from Valpak-2 information;

- Address
- Sale date
- Sale price
- Government valuation
- Land area
- Floor area of house
- Year of construction
- Exterior cladding
- Roof material
- Condition of exterior and roof materials
- Category – Family dwelling, Own Your Own, Rental flats.

To further develop the database it was necessary to make subjective, visual observations of the area to include a variable for view, as some houses have a panoramic view and others have no view at all.

Detailed maps of the Newlands area were obtained from New Zealand Department of Survey and Land Information. These were used to take measurements to determine the following variables:

- The distance measured from the centre of each lot to the transmission line
- The distance measured from the centre of the lot to the nearest pylon.
- Whether property is on an arterial street or not.

The maps used are at a scale of 1 cm = 20 metres. The distance measurements are accurate but may not be precise in every case as the centre of each lot had to be estimated.

3.7 CASE-STUDY BACKGROUND

3.7.1 New Zealand

Within New Zealand, all the HVOTLs are AC with the exception of the line that crosses the Cook Strait, which is a Direct Current (DC) line that runs on the seabed connecting the power supply between the two main islands. The HVOTLs carry the electricity from the power stations to a regional transformer station where the voltage is reduced to low voltage mains supply and distributed to individual properties, by predominantly underground cables.

To place the HVOTLs underground is reported by the power suppliers as being financially prohibitive. Throughout the residential areas it is also physically restrictive. In addition to the capital cost, the ongoing maintenance costs are less for overhead cables where any issues can be directly dealt with and lines can be easily checked on a regular basis. To place lines underground would also require the negotiation and purchase of an easement, which may be prohibitive in heavily populated areas.

Home ownership has been a desire of most New Zealanders, for the last 160 years. The majority of early European settlers who immigrated to New Zealand came searching for a new beginning which included owning their own patch of dirt. There have been many changes to the laws relating to land ownership since 1840, with the current law related to the ownership and transfer of land in New Zealand being the Land Transfer Act of 1952 and the use of land by the Resource Management Act 1991.

3.7.2 Legislation relating to placement of HVOTLs in NZ

The Resource Management Act of 1991 was introduced after an increased awareness and understanding of environmental issues and problems associated with land development and management. The Resource Management Act 1991 governs local city council development of the District Plan. The District Plan contains the regulations, objectives and policies related to development of land in each city. The District Plan has a direct impact on whether an external effect can be placed in the residential zone. Each local council has its own interpretation of what is a suitable activity within each zone, and will have plans in place in protect the living environment of residents within the residential zone.

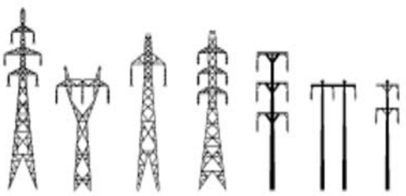
The HVOTLs and towers that are already in place throughout New Zealand have existing use rights; however, should they need upgrading then approval needs to be sought under the Resource Management Act 1991, and must comply with the Act. Any new towers or lines also need to comply with the Act.

The Electricity Act of 1992 covers electricity supply and distribution in New Zealand. The Act covers all works that existed prior to 1 January 1993 and allows access to private property to maintain the HVOTLs. Most HVOTLs in New Zealand were constructed prior to 1988 and were therefore in existence at the time of the Act and classified as ‘existing works’. The Act maintains that the HVOTLs are ‘existing work’ and therefore maintains the right to occupy private land without the need for landowner arrangements. Therefore, there is no easement or right of way associated with the majority of HVOTLs in New Zealand. This is in direct contrast to the arrangements in other countries, which require either a transmission line corridor or easements over private property (DesRosiers 2002, Kinnard 1995, Colwell 1990, Kroll 1994, Callanan 1995).

Transmission lines are the arteries of New Zealand’s National Grid, owned and operated by Transpower NZ. Transmission lines take power from the generators to substations where it is supplied to local distribution companies and large industrial consumers.

Transpower owns and operates 12,175km of high-voltage transmission lines (Transpower 2012). Except for the high-voltage direct current (HVDC) link across Cook Strait, all transmission lines carry at least one alternating current (AC) circuit, with a minimum of one conductor per phase. There are three phases per AC circuit (Transpower 2012).

The core of the National Grid is the 220 kV network in each island and the HVDC link between them. The 220 kV lines connect the largest power stations with the main load centres. Provincial centres and smaller power stations are connected by transmission lines operating at 110 kV, 66 kV and 50 kV. Transpower also has some local distribution lines operating at 33 kV and 11 kV.



Selection of Towers used for carrying HVOTLs

(Source – Transpower NZ website)

'Transpower's lines are made up of one or two circuits carried on steel towers (or pylons), or wood or concrete poles. These drawings show the standard configurations and components of the different transmission lines' (from Transpower http://www.gridnewzealand.co.nz/transmission-lines). The two styles on the right hand side of the diagram are the least common for HVOTL, and are more common for the local distribution lines.

The placement of HVOTLs in New Zealand is unique in the world, with some towers being placed on private property, and a large number of the lines traversing the property including the house and any other structures on the site.

Transpower NZ have been looking to introduce a new transmission line, which would be 400kv; however, this is over rural land and will be held within a transmission corridor. Due to permission being required under the Resource Management Act 1991, and the approval of landowners in the acquiring of the easements, the new 400kv line has not progressed at this stage.

Under the New Zealand, Resource Management Act 1991, for an existing use right to continue to be authorised, the effect of the use must remain the same or similar in character, intensity and scale. The HVOTL that is the subject of this case-study had existing use rights of access, which means that there was no easement or encumbrance noted on the land ownership certificate of title. If the existing use was to be altered in any way (that is, the lines were upgraded or moved) then there will be public input, which will require an easement to be created.

Transpower NZ endeavours to work closely with the owners of the land which have a HVOTL over or on it. Its preference is to have a written agreement with the owner, which sets out rights of access and a code of conduct for workers on the site. Gradually Transpower NZ has been working through trying to get these agreements over recent years. In the absence of a written agreement, Transpower reverts to its historical rights of access held under the Electricity Act 1992. All new HVOTLs have a registered easement and compensation will be negotiated for this right. For an upgrade to an existing line where there is no easement, compensation will only be paid for 'injurious effect'.

'The width of the easement needed for a transmission line will vary depending on the design of the line and towers, the number of circuits, and the voltage carried by the line. As an example, a new double circuit 220 kV transmission line would have a minimum easement width of 50 metres (larger in some places to accommodate the extent to which the conductor can swing out in longer spans)' (Transpower 2013).

Home ownership has been reinforced in New Zealand culture with around 75 per cent of adults owning their home as opposed to renting. This pride in property ownership, and strong feelings about protecting one's home and lifestyle, is the basis of the NIMBY syndrome. HVOTLs are generally classified as a NIMBY, being a structure that residents are aware has to be placed in the community but which they do not want it in their backyards.

If the whole community is sharing the burden of social responsibility for services, rather than individuals, then the property owners can experience a feeling of equity. NIMBYs tend to occur in neighbourhoods which are economically, socially and politically less powerful than other neighbourhoods. 'There is less of an interest-based resistance to such development in these neighbourhoods. However, even when the interest might be strong, resistance in these areas tends to be more difficult. These neighbourhoods generally do not have easy access to technical and legal assistance, and they often do not contain as high a proportion of residents who are also homeowners' (O'Looney 1995).

3.7.3 Information provided to potential buyers

On purchasing a residential property in New Zealand there is no legislated requirement of disclosure on the part of the vendor. There is a requirement by the Real Estate agent and the vendor to not misrepresent or to provide misleading information. The information provided is only the information that is specifically requested by potential purchasers.

It is common practice for a potential buyer to obtain a copy of the Land Information Memorandum (LIM), and less common, a Project Information Memorandum (PIM). Both of these reports are obtained for a fee from the local city council. The LIM contains information relating to the land, such as:

- any special feature of the land Council knows about including the downhill movement, gradual sinking or wearing away of any land, the falling of rock or earth, flooding of any type and possible contamination or hazardous substances.
- information the Council holds on private and public stormwater and sewerage drains.
- rating information.
- any consents, notices, orders or requisitions affecting the land or buildings.
- District Plan classifications that relate to the land or buildings.
- any other classifications on the land or buildings notified to the Council by network utility operators in relation to the Building Act 2004.
- any other information the Council deems relevant (Wellington City Council 2013).

For those properties where there is existing use rights for the HVOTLs, and no easement has been negotiated, the existence of the HVOTLs would be registered on the LIM to notify any potential purchaser.

The PIM refers to the Property itself, and is usually obtained prior to a building consent as it sets out the building plans, compliance, and any active building consents that have been applied for within the immediate area. This report would not contain information relating to the HVOTLs.

The other document that is obtained on purchase is a copy of the certificate of title. The certificate of title will include any easements that are registered on the parcel of land. Within the case study area of Newlands, the HVOTLs were in place prior to the houses being built, and easements were not negotiated (and therefore not registered) on the titles. The right of access by Transpower (owner of the HVOTLs) to the private property to maintain the towers and lines is provided under the Electricity Act.

After the HVOTLs are removed, there is no longer any visual evidence of the lines. As they are not placed underground there is no easement created, and the reference would be removed from the LIM.

3.7.4 Newlands case-study

This case-study uses the suburb of Newlands in Wellington as it was traversed by two 110kv transmission lines. The Newlands area comprises predominantly single family residential homes in the lower price category. Newlands was developed in the 1960s, well after the construction of the transmission line. Therefore, the effects may have diminished over time as the towers and lines have become accepted as part of the landscape.

This case-study addresses impacts on value of residential land and improvements. The Newlands area is a lower socioeconomic area and a different result may be achieved using medium or high cost housing area.
Figure 3.1 and 3.2 illustrate the close proximity of the pylons to the residential properties within the Newlands area.

Figure 3-1 Pylon on privately owned property in Newlands

Newlands was chosen as the study area because two 110kv transmission lines transect it. The two lines through Newlands are the Khandallah-Takapu Rd line, which was erected on 1 December 1924 and then upgraded in 1983. The Khandallah- Takapu Rd line runs through the side of Newlands. The second line is the Khandallah-Haywards line which was erected on 1 August 1931, upgraded in 1981, and removed in 1996 and forms the case-study for this research. In both cases the pylon tower was 26 metres high and carried 110kv.

Newlands was developed in the 1960s with predominantly single family homes of medium cost construction. The majority of homes now would fall into the first homebuyers or low income brackets. The Sunhaven area on the eastern ridge that overlooks the harbour has some more expensive homes. These homes have panoramic views, but are also exposed to both the prevailing northerly and the strong southerly winds. As the Wellington area is strongly affected by wind many buyers look for sheltered sites, which often negates any premium for a view.

Figure 3-2 Pylon in backyard of house in Newlands

3.7.5 Location

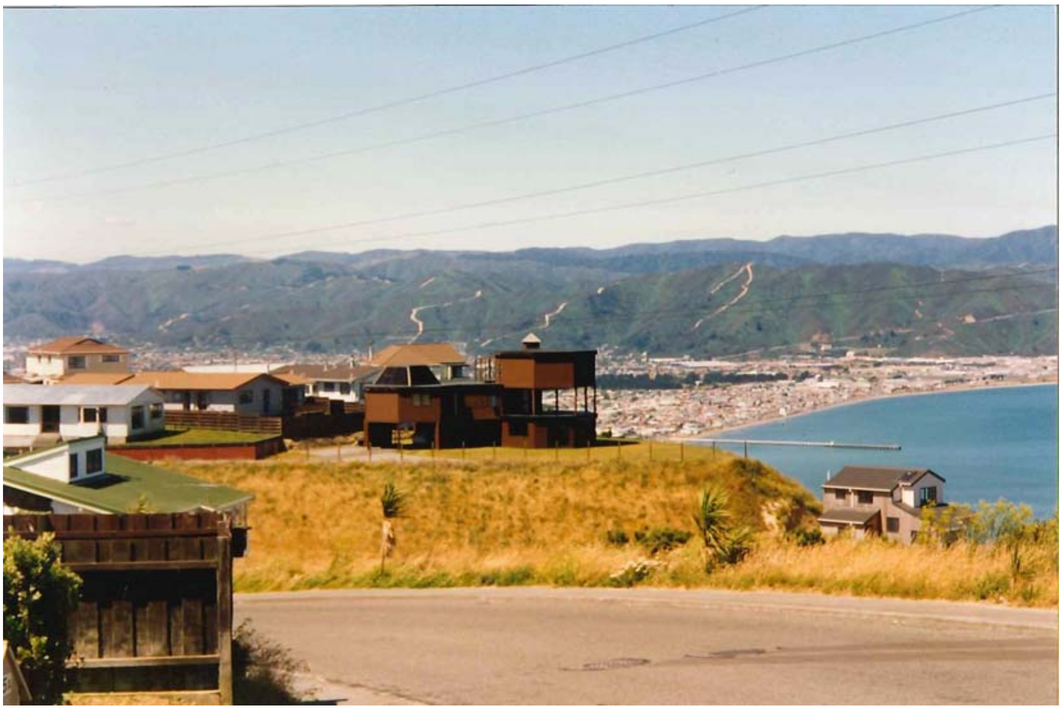
The case-study is based on the suburb of Newlands, which is accessed from the Wellington to Porirua motorway; approximately five minutes drive north from Wellington City. Maps of the area in relation to Wellington city are located in Appendices E and F. Newlands was developed for residential housing, mainly in the 1960s and 1970s. Housing is of a wide range but is predominantly low to medium cost. First home owners are attracted to the area because of the lower housing costs, as compared to the Wellington central areas. A regular public transport service operates in the area, with buses to and from the Wellington Central Business District.

There are three primary schools, one intermediate and one secondary school servicing the education needs of the Newlands area. A small commercial shopping centre is located in Newlands Road with a major shopping centre nearby in Johnsonville. The area has a hilly terrain with most of the houses on the southeast ridge having a panoramic view of Wellington harbour and the Hutt Valley (Figures 3.3, 3.4 and 3.5). The houses with the panoramic view are also generally exposed to the strong southerly wind and were also in close proximity to the HVOTL prior to its removal.

Figure 3-3 Harbour view before tower removal

Figure 3-4 View across the harbour after tower removed

Figure 3-5 View of Hut Valley before tower removal



Housing comprises predominately single, stand alone family dwellings with approximately 20 per cent being own-your-owns or rental properties.

There are two newer subdivisions in the area. Sunhaven is situated on the eastern ridge where the Haywards line transects Newlands. This subdivision is approximately 30 years old with more superior housing, although they would still not be classed as 'executive'. The views are panoramic and houses receive all day sun, which is a sought after factor in Wellington. The newest subdivision is off Woodridge road on the northern edge of Newlands, which is outside the study area. The houses were mainly built in the 1990s, and are of average construction, and are stand alone, single dwellings.

Section sizes vary in size from 360 to 2790 square metres, with the mean being 623 square metres. Floor area of dwellings varies from 60 to 290 square metres, with a mean of 127 square metres.

A large section of the suburb has overhead electric feeder distribution lines and telephone lines overhead, which are prominently visible features in local views. These are a limitation to this study as they do provide visual pollution that may mask the visual impact of the HVOTLs.

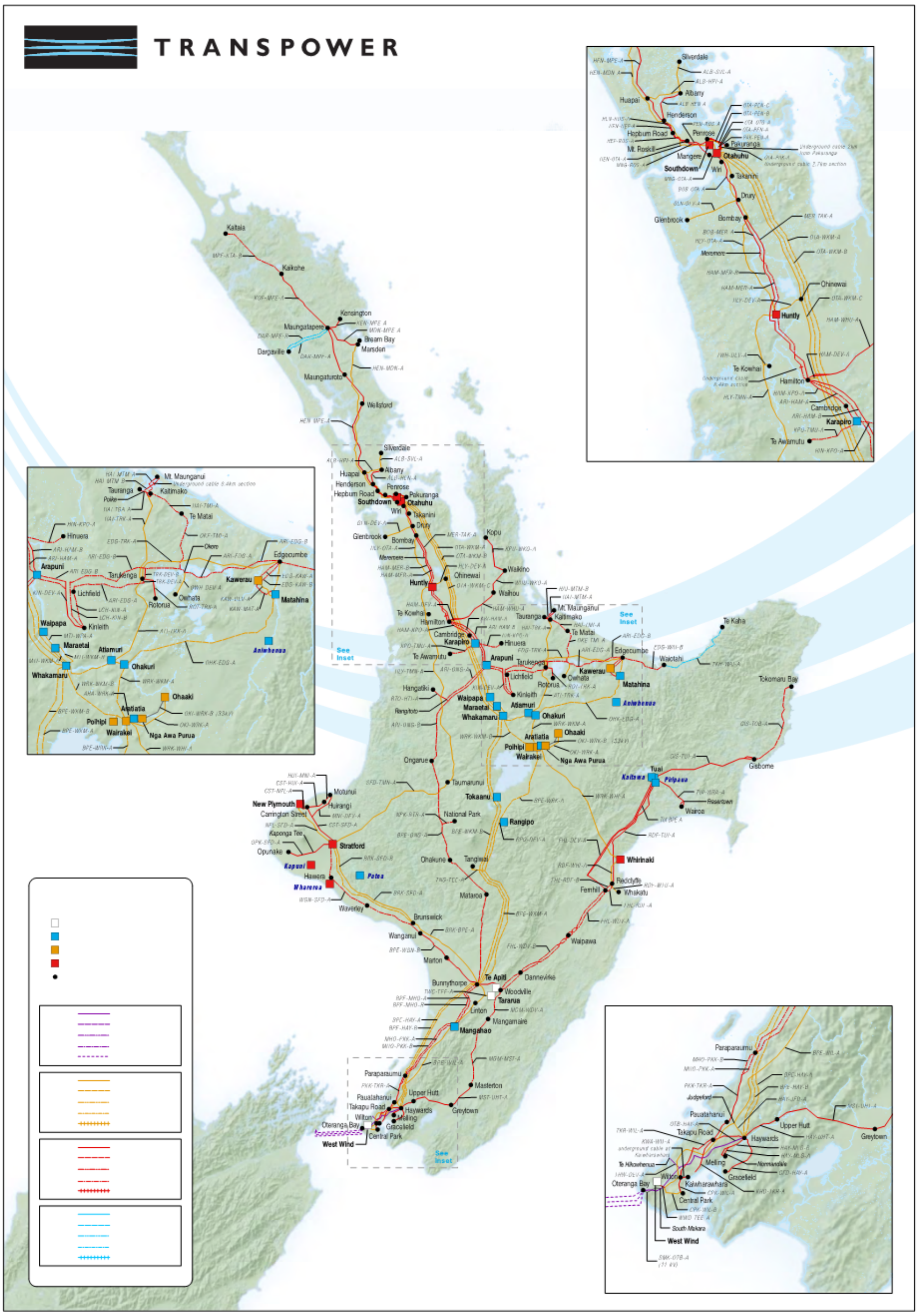
The landscaping in the area varies depending on whether the property is on the ridge or in the valley. Those houses along the ridge or in exposed positions tend to have little landscaping. However, the majority of homes in the valley are well landscaped with a lot of mature trees to soften the view of the HVOTLs. (refer Figure 3-6)

Figure 3-6 Landscaping to soften view of lines

As the majority of houses were constructed after the transmission line and towers, the houses could be orientated to have the least visual impact; however, this does not appear to have been taken into account. There are examples throughout the area where the house has been placed directly next to the tower, with one example observed where the tower is between the house and garage (figure 3.1).

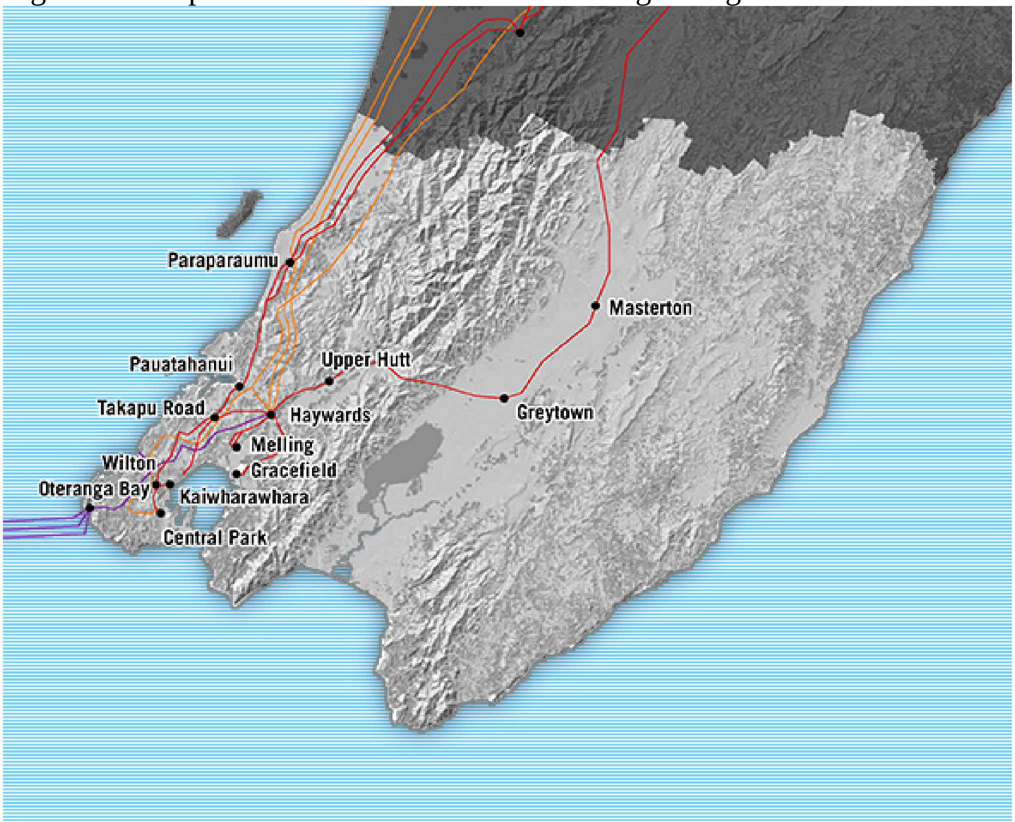
The Wellington city airport flight path passes directly over the Newlands area. Investigations have shown that as the path transects the whole area there appears to be a fairly constant noise impact over all houses. Therefore, the impact has not been assessed as part of this study.

Figure 3-7 Map of Transmission Network – New Zealand
Source: Transpower NZ 2011



Source: Transpower NZ 2011

Figure 3-8 Map of transmission network - Wellington region



3.8 SUMMARY

This chapter discussed the methodology used, and also outlined the case-study area. The methodologies outlined indicate that a Hedonic pricing model in the form of a regression analysis is the best method for analysing the sales transaction prices to determine the impact on price before and after the removal of the HVOTLs. This method is also well accepted within the property/real estate research as being appropriate for the analysis of impacts on property values.

The second methodology to be used is an analysis of the sales data and demographics over the period before and after the removal of the HVOTLs to determine the data trends and whether any patterns can be determined.

The third methodology to be used is a case-study and control area using repeat sales to determine whether there has been an impact on sale price following the removal of the HVOTLs.

The sample selection has also been discussed along with the importance of selecting a fully representative sample, with the sample being of a sufficient size to provide a statistically significant analysis.

In the next chapter the results are outlined and discussed, followed by the conclusions.

Chapter 4: Results and Discussion

4.1 INTRODUCTION

In Chapter 3, the methodology used for this study was outlined, with the principal methods being a Regression analysis and a Repeat Sales Analysis. The case-study area was also detailed to provide a background to the physical location, as well as the structure of HVOTLs within New Zealand.

In this chapter the results will be outlined in the following order:

- 4.2 Sales Information
- 4.3 Regression analysis results **before** the HVOTLs were removed
- 4.4 Regression analysis results **after** the HVOTLs were removed
- 4.5 Sales data analysis to determine patterns of change in; property size, length of time on market, changes in sale price, and number of sales
- 4.6 Demographic changes
- 4.7 Repeat sales analysis with case-studies.

The conclusions will be discussed and applied to the research questions in the next chapter.

4.2 DATABASE

1. The data for this study was obtained from three different sources within New Zealand. The bulk of the sales data has been obtained from Headway New Zealand. This database was previously managed by Valpak software. This information is collected into a database, which records property sale transactions that are supplied by the lawyers carrying out the

conveyancing on transfer of any property. The database includes sales information, including the following: address, sale price, legal description, title number, rating number, rating valuation, age of construction, condition of improvements (exterior and roof), construction material (exterior cladding and roof), planning zone, floor area, and land area. This database does not include any information regarding date of listing, number of bedrooms and number of bathrooms.

2. The data relating to number of days on the market is supplied by the Real Estate Institute New Zealand, as this information is not included in the Headway NZ database. The additional information gained from this database is the listing price against the sale price. The roll numbers within the two locations are taken from the same database that the case-study sales analysis was obtained.

3. The demographics information was obtained from the Statistics New Zealand census information which is available online. The census information is collected every five years and every person, no matter what age, who is in New Zealand on that date, is required to complete the survey. The information is collected and reported by Statistics New Zealand.

4.3 REGRESSION ANALYSIS RESULTS BEFORE HVOTLS REMOVAL

The results from this study have been documented by Callanan & Hargreaves (1994), Callanan (1995), and Bond & Hopkins (nee Callanan) (2000). For completeness of this thesis, the process and results from that study are outlined here. Callanan (1995) provides a summary that the predominant effect comes from the towers rather than the lines themselves. The towers have a 27 per cent negative effect on value at a very close distance (adjacent to 20 metres), which drops to 5 per cent at 50 metres. After 50 metres the effect diminishes quickly to a negligible amount at 100 metres. The presence of a transmission line (as separate from a tower) in the Newlands area has a minimal effect of less than negative 1 per cent for those properties directly under the line, and is not a statistically significant factor in the sales price.

4.4 VARIABLE SELECTION

The variables that were used in the analysis are outlined in the following table

Figure 4-1 Variables used in the analysis

Property Features	Land area
	Floor area
	Exterior condition
	Roof condition
	Condition of building
	Decade of construction
	Panoramic View or not
	Arterial road
Location	Location 1 to 8
Market	Year of sale
HVOTLs	Distance from each line
	Distance from each pylon
	Log of distance – natural and log to base 10
	Reciprocal of distance times 100
	Hybrid of distance to line plus distance to pylon
	Dummy variable for distance to line and pylon

An explanation and discussion of the variables used follows.

4.4.1 Floor area

This is the total floor area of the house expressed in square metres. This data was obtained from Headway New Zealand. The data is provided to Headway by Valuation New Zealand, which collects it as part of its Rating valuation information. Note - Rating valuations were called Government Valuations in the early part of this data collection. This measurement will not take into account any additions made to the house since the last Rating Valuation was undertaken. The floor area obtained from Valuation New Zealand is rounded to the nearest ten metres, which may introduce a small degree of error. However, this is the most precise measurement available without physically measuring each house. Where the garage is external from the house, it is not included in the total floor area square meters.

The floor area was chosen over the number of bedrooms and bathrooms for two reasons. First, the number of bedrooms and bathrooms is not included in the Headway sales database and would need to be obtained from the Real Estate sales database which is not as reliable as it is not a legislated requirement for this information to be provided. Second, an analysis was carried out on this information from the real estate database and it was found that the number of bedrooms has not really changed over the 16 year period. There was an average 3.13 bedrooms in 1994, rising to 3.2 bedrooms in 2010. However, the floor area has increased over the same period, indicating that houses have got larger but the number of bedrooms has not altered.

The regression analysis model provides a positive amount of $371 per square metre of floor area.

4.4.2 Land area

This is the total land area expressed in square metres. This data was also obtained from Valuation New Zealand. The regression model provides a positive amount of $16 per square metre of land area.

4.4.3 Decade of construction

This variable shows the decade in which the house was constructed. This was obtained from Valuation New Zealand records. A dummy variable was used in the calculation: for example, if constructed in the 1980s a 1 was given, if not a 0. Houses built in the 1950s proved to be a significant factor within the regression model with a result of negative $7496. Meaning that houses built in the 1950s were $7496 less than the average.

4.4.4 Panoramic view

The houses situated on the eastern ridge have a panoramic view around the Wellington Harbour and some also have a view over the Lower Hutt valley and the Eastern Bays. The houses with a view are also generally exposed to the wind. A dummy variable was used to distinguish if there was a view or not. The information was obtained by visual observation from each property.

The regression model indicates a decrease of $4058 for those properties without a panoramic view.

4.4.5 Condition of exterior cladding and roof

The houses were grouped into three categories:

Condition 1 – Very good, above average

Condition 2 – Average

Condition 3 – Poor, Below average.

The information was obtained from the Valuation New Zealand records, which may not allow for any upgrading work done since the last Rating valuation.

The regression model indicates that the condition is an important variable and has added $23,341 to Condition 1 houses and $18,444 to Condition 2 houses.

4.4.6 Location

The whole area was split up into eight different locations as follows:

Location 1 – Somes Crescent, Sunhaven, Fernhaven
Location 2 – Woodridge subdivision
Location 3 – Kenmore Street North to Woodridge
Location 4 – Glanmire Road, Edgecombe North to Kenmore
Location 5 – Black Rock Road South
Location 6 – South of Salford Road
Location 7 – Salford Street to Stewart Drive
Location 8 – North of Stewart Drive.

The area was split into different locations to distinguish if there were any significant neighbourhood features. This information was obtained by fieldwork and the main arterial roads were used to separate the area out into eight locations.

The regression model indicates a negative amount of $4783 for those houses in Location 4.

4.4.7 Year of sale

A variable was introduced to indicate at which time period over the five years prior to the removal of the HVOTLs, the sale was made. There are ten six-monthly time periods over the five years.

The regression model has indicated as significant the following amounts for houses sold in the following time periods:

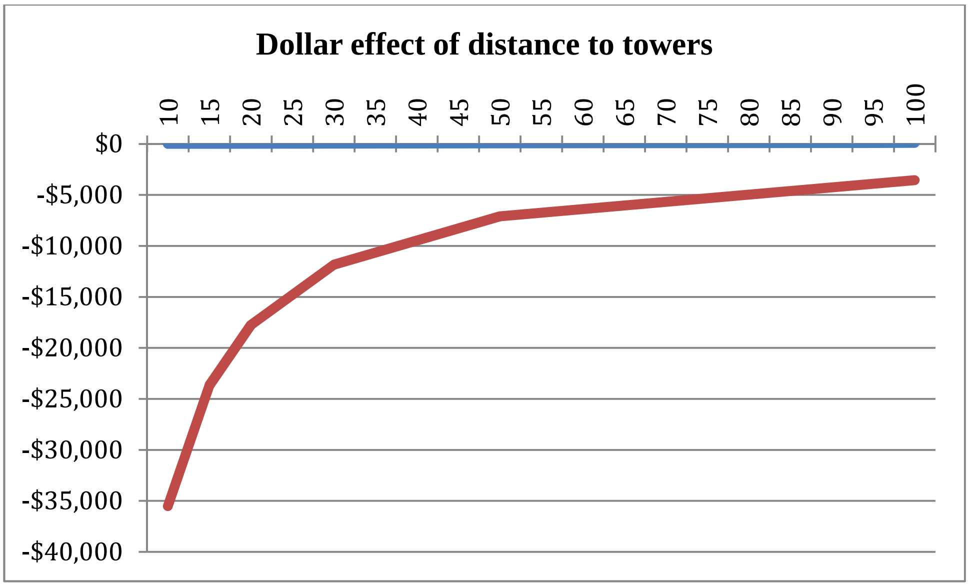
First half of 1989	-	+$23,915
Second half of 1989	-	+$23,189
First half of 1990	-	+$18,670
Second half of 1990	-	+$15,385
First half of 1991	-	+$8,715

The New Zealand residential market did take a strong upswing in 1989, which will explain the variation for this time period.

4.4.8 Transmission line-related variables

A number of different data transformations were assessed to best describe the effect distance from the transmission line and towers have on property values. The best fit was found to be reciprocal of the distance to both the lines and the towers, times 100. This indicates a diminishing effect on property values, which reduces to a minimal amount around 100 metres.

Figure 4-2 Dollar effect of distance to towers



The different models tested showed an inconsistent result on sale price for distance from transmission lines but consistently a negative result was obtained on the distance to towers. In the final model, an effect of -$3551 times the reciprocal distance was obtained on the Khandallah-Haywards line. The final model indicated the amounts shown in Table 4-1.

Table 4-1 Percentage of average house prices against distance from nearest HVOTL

100 metres	-$3551	-2.7%
50 metres	-$7,102	-5.4%
30 metres	-$11,836	-9.1%
20 metres	-$17,755	-13.6%
15 metres	-$23,673	-18.2%
10 metres	-$35,510	-27.3%

This indicates a reduction in house prices of around 20 per cent of the average sale price for houses very close to the towers, and dropping off to 2 per cent at 100 metres. The closest tower in the area is 10 metres from a house, which places the tower within the house lot.

4.4.9 Results

Econometric analysis techniques were used to determine a suitable regression equation to quantify any transmission line effects. An index was also constructed to determine any variation in sales prices for those houses near the lines as compared to houses in the same area but unaffected by the transmission line, which is referred to as the control area. Calculations were also carried out to pick up any trends and to gain a better understanding of the area and data. These trends are illustrated in the table below.

Table 4-2 Average house prices according to distance from HVOTL

Distance from transmission lines	**Average sale price**	**Number of sales**
Within 10 metres	$121,652	18
11-50 metres	$129,287	30
51 – 100 metres	$130,460	36
101 – 150 metres	$127,361	44
150 – 200 metres	$131,852	27
200 – 250 metres	$118,804	19
250 – 300 metres	$117,757	10
Over 300 metres	$121,899	260

The correlation matrix was carried out using IBM SPSS. The matrix was analysed and any variables with a correlation of more than .7 were dropped from the equation.

A number of different regression models were tested to obtain the most appropriate specification with the best line of fit. Different methods were used to find the best fit for the distance to the transmission line and tower as well as for the house area and lot size. It was found that the most appropriate expression for the transmission line and tower variables was to transform the data using a reciprocal of the distance, times 100. By using this transformation the data took on a non-linear form, which reflected the impact at a close distance but very little further away. This relationship is demonstrated in figure 4.2 above.

Regression equations were then run on all the different alternatives. Once the best model was achieved, the regression was carried out at varying distances from the line. In all of the equations certain variables consistently appeared as significant. These variables all appear in the final result.

The goodness of fit statistics generated by the model indicates that it is well specified, with the standard error, as a percentage of average sales price, being about 8 per cent.

The level of confidence was set at 95% and also tested at 90% and 85%. The transmission lines became significant at 85%, giving a minimal negative effect of 1 per cent of the average selling price to those houses directly under the lines. This is not a reliable result, given the lower level of confidence, and the 1 per cent result could be explained within the standard error. The results have therefore been based on a 95% confidence level. The degrees of freedom are 295, which is statistically acceptable.

For the period prior to the removal of the HVOTLs, the adjusted R-squared is .74, which indicates that 74 per cent of the total variation of the dependent variable can be explained by the regression equation.

The F test is a ratio of the Mean Square explained divided by the Mean Square unexplained. The result in this equation is 64.22, which shows that the chances of the equation being an accidental effect are very low.

The multiple linear regression equation can be expressed as follows:

$$Y = a + b_1X_1 + b_2X_2 + \ldots b_{13}X_{13} + E$$

Where ‘a’ is the intercept and b_1 b2 etc are the partial regression coefficients, or the slope of the regression line. ‘A partial regression coefficient is the average change in the dependent variable resulting from an increase of one unit in the independent variable when all other independent variables are held constant’ (Gray 2012, p. 470).

a = constant or Y intercept
b = coefficient or slope of the regression line
x = independent variable
E = the error term or residual value. This is the difference between the predicted and actual values for each case.

The results can be expressed as the following equation, with the Sales Price as the Dependent Variable:

Sales Price = \$46,985 + \$371 X_1 + \$16 X_2 + \$23,915 X_3 + \$23,189 X_4 + \$18,670 X_5 + \$15,385 X_6 + \$8,715 X_7 + \$23,341 X_8 + \$18,444 X_9 + (\$4,783) X_{10} + (\$4,058) X_{11} + (7,496) X_{12} + (3,551) X_{13}

The equation variables are set out in the following table, where:

(M) = Multiply by a measurement
(A) = Constant amount

Number of Observations	=	330 sales
Degrees of Freedom	=	295
Adjusted R-Squared	=	74%
Standard error as % of Sales Price	=	8.5%
F Test	=	64.22
Durbin-Watson test	=	1.87

Table 4-3 Regression equation breakdown

Variable		Coefficient		T Values	Sig.T	Beta
Y	Sale price		A			
b	Constant - (Intercept)	\$46985	A			6.152
X_1	Floor Area	\$371	M	22.2	.0000	0.679118
X_2	Land Area	\$16	M	3.5	.0005	0.128069
X_3	Sale in first half of 1989	\$23915	A	12.3	.0000	0.399677

X_4	Sale in second half of 1989	$23189	A	11.3	.0000	0.364857
X_5	Sale in first half of 1990	$18670	A	8.5	.0000	0.269518
X_6	Sale in second half of 1990	$15385	A	6.3	.0000	0.198773
X_7	Sale in first half of 1991	$8715	A	4.0	.0001	0.127532
X_8	Very good, Above average condition	$23341	A	3.6	.0004	0.499100
X_9	Average Condition	$18444	A	2.8	.0056	0.390230
X_{10}	Location four	$(4783)	A	-3.5	.0006	- 0.110771
X_{11}	Non panoramic view	$(4058)	A	-3.0	.0033	- 0.092067
X_{12}	Constructed in 1950s	$(7496)	A	-3.0	.0033	- 0.105162
X_{13}	Proximity to Pylon	$(3551)	M	-5.0	.0000	-0.137888

The T test, using a 95% confidence interval and a normal distribution, is 1.96. Therefore, all variables, as a default on SPSS, are included if they are above 1.96. The T is a ratio of the Beta value of the variable divided by the Standard error of the variable.

The significant T (Sig T) shows the significance of the T value. It is the statistic used to test the null hypothesis that there is no linear relationship between a dependent variable and an independent variable or, in other words, that a regression coefficient is equal to 0.

The standard error is expressed as a measure of how much the value of a test statistic may vary from sample to sample. It is the standard deviation of the sampling distribution for a statistic. In this study the standard error is 8.5, which is expressed as a percentage.

4.4.10 Summary

The results apply to an area consisting of all house sales within three hundred metres of the transmission corridor, which is the area on the eastern side of Newlands Road. This area is later referred to as Newlands East and Newlands South, as defined by the Statistics NZ Census meshblock.

A separate regression equation was developed as a control group for the area, to the western side of Newlands Road and later referred to as Johnsonville East, as defined by the Statistics NZ Census meshblock. This area is unaffected by the HVOTLs. This equation is set out in appendix two and shows the same variables as being significant, excluding the transmission lines and towers

The area, which is affected by the HVOTL corridor, also includes an area that has panoramic views across the harbour. A variable has been added for the view to isolate this from the HVOTL variable.

The results show that the effect of having a pylon close to a particular property is significant and has a negative effect on sale price of 27 per cent at 10-15 metres from the pylon, decreasing to 5 per cent at 50 metres. This effect diminishes to a negligible amount after 100 metres.

The HVOTLs are separated to a variable for the lines, and then a variable for the towers. The lines themselves, in the Newlands area, have a minimal negative effect on sale price, which is not statistically significant and has therefore been concluded as not having an impact. The towers have a negative effect on sale price at a close distance, which reduces rapidly from 50 metres to a negligible amount at 100 metres.

In the next section, the same analysis is carried out following the removal of the HVOTLs.

4.5 REGRESSION ANALYSIS RESULTS AFTER HVOTLS REMOVAL

4.5.1 Introduction

In this section a series of regression analyses are carried out for the periods from 1994 onwards to determine any differences in the equation following the removal of the HVOTLs.

The first analysis includes sales from 1994 onwards, and then a further analysis is carried out each year to determine whether the significance of the variables alter after the HVOTLs were removed. Finally, an analysis is carried out on sales from 2000 through to 2010.

As the equation prior to 1996 was trying to identify the importance of the HVOTLs, all locations in Newlands were included. In the equation after removal, the areas were identified by their roll number, which relates to the same location boundaries that were stipulated in the analysis prior to removal of the HVOTLs.

In order to keep the analysis consistent, a stepwise method was used and was set at 95% confidence interval. The HVOTLs were significant in the pre-removal analysis at the 95% interval. Results have been rounded to the whole dollar, as per the pre-removal analysis.

4.5.2 Results of analysis for period 1994-1999

The results of the analysis that incorporates all sales over the total period from 1994 through to 1999 is as follows and has similarities with the pre-removal analysis in relation to land area, floor area and condition.

The results are displayed in the order that they became significant. Results show that the period 1994 had a reduction in sales price (of $7,815), which was the period before the HVOTLs were removed. Results then show the significance of the sales periods 1997, 1998 and 1999, with a positive variable of $15,599 (1997), $30,020 (1998), and $40,182 (1999). This was the period immediately following the removal of the HVOTLs and allowing for the stigma to persist for three years following the removal.

Table 4-4 Multiple regression analysis results for sales from 1994 to 1999

Variable	**B**	**Std error**	**Beta**	**t**
Constant	$59,462	$2,442		24.340
Floor area (M)	$454	$15	.511	29.406
Sold 1998	$30,020	$1,892	.299	15.864
Sold 1999	$40,182	$2,799	.256	14.355
Sold 1997	$15,599	$1,763	.169	8.848
Land area (M)	$11	$1	.132	7.535
Roll 16780	($11,553)	$1,539	-.134	-7.504
Roll 16710	($36,888)	$4,091	-.155	-9.016
Built 1990s	$24,215	$3,180	.132	7.615
Unknown age	$37,655	$6,113	.107	6.159
Sold 1994	($7,815)	$1,749	-.085	-4.467
Built 1980s	$7,726	$1,823	.076	4.238
Built 1910s	$17,161	$5,699	.051	3.011

Durbin Watson = 1.853

R squared = 54%

Sales = 1896

Degrees of freedom = 1638

4.5.3 Results for yearly analysis

The same variables were used to calculate an analysis for each year in isolation, with the difference between the inputs in each analysis outlined in the table below. This analysis was carried out to determine at what point the stigma disappears from the market. The 1995 result is still showing a negative amount of -$10,247, as is 1996 with -$12,763, and then the direction of the adjustment changes to positive from 1997 onwards. There will be a lag in the sales data as the market adjusts; however, it is clear from these results that the HVOTLs had a negative impact, and on their removal in 1996 the market adjusted upwards. All variables are expressed as an amount, other than 'Floor area' and 'Land area' which are multiplied by the number of square metres per property.

Table 4-5 Regression results carried out on an annual basis

Variable	1994 onwards	1995	1996	1997	1998	1999
Constant	$59,462	$63,030	$72,799	$69,058	$58,823	$68,361
Floor area (M)	$454	$465	$473	$469	$466	$469
Sold 1998	$30,020				$23,090	
Sold 1999	$40,182					$30,665
Sold 1997	$15,599					
Land area (M)	$11	$8	$8	$8	$9	$8
Roll 16780	($11,553)	($11,040)	($10,936)	($10,926)	($11,876)	($11,758)
Roll 16710	($36,888)	($34,298)	($34,405)	($34,545)	($35,897)	$35,974
Built 1990s	$24,215	$32,434	$34,889	$34,537	$29,689	$32,827
Unknown age	$37,655	$33,224	$31,746	$31,802	$32,639	$33,172
Sold 1994	($7,815)					
Built 1980s	$7,726	$9,105	$9,979	$9,804	$9,438	$9,675
Built 1910s	$17,161					
Sold 1995		($10,247)				
Avg condition		$9,537			$8,265	
Sold 1996			($12,763)			

Roll 16740				($9,488)		

A separate analysis was carried out on the sales from 2000 through to 2009. The results show the same base variables of floor area and land area as being consistently important, and then as a negative for the early years in the 2000s. This can be explained by the downturn in the market in the early 2000s. Of interest is that the sub-location variable is no longer significant.

A summary of the test from the final equation from 2000 onwards is illustrated in table 4.6 below.

Table 4-6 Results from regression using sales from 2000 onwards

	results
Durbin Watson	1.850
R squared	68%
Sales	3336
Degrees of freedom	2932

4.5.4 Correlation

As with the analysis prior to the HVOTLs being removed, the Pearson Correlations were calculated and those variables with a correlation over .7 were removed. ‘The Pearson correlation is a measure of a supposed linear relationship between two variables, both measured at the continuous and scale level’ (Gray 2012, p. 402).

This measurement is appropriate to use in this analysis as the variables are linear. The correlation has been checked for each equation, with the equation from 1994-1999, which includes the period prior to the removal and then for four years after. The variables that were highly correlated are set out in the following table 4.7.

Table 4-7 Variables showing a high correlation and removed from final equation

Variables	correlation	Variable removed
Fibrolite exterior Built in 1980s	.734	Fibrolite exterior
Average condition Excellent condition	.874	Excellent condition
Fibrolite exterior Weatherboard exterior	.776	Fibrolite exterior

The variables ‘Fibrolite exterior’ and ‘Excellent condition’ were both removed. Both variables refer to the exterior construction of the dwelling.

4.5.5 Durbin Watson, T tests, r squared (coefficient of determination)

The T test using a 95% confidence interval and a normal distribution is 1.96. Therefore all variables, as a default on SPSS, are included if they are above 1.96.

The T is a ratio of the Beta value of the variable divided by the Standard error of the variable.

The coefficient of determination is .55 for the equation, including sales from 1994 through to 1999, which indicates that the association is very high, and at least 25 per cent of the variance is shared (Gray 2012). The co-efficient increases to .66 when the sales to 2010 are added in.

The Durbin-Watson test is 1.85, which indicates that there is a very low risk of autocorrelation in the equation. The Durbin-Watson test for the equation prior to the removal of the HVOTLs was 1.87.

There is an assumption in regression analysis that the residual values are independent of each other; that is, they are not inter-related. The Durbin-Watson test is used to indicate whether the unexplained individual errors are independent of each other. The Durbin-Watson test has a break down as follows;

Table 4-8 Durbin Watson statistic

Durbin-Watson Statistic	**Interpretation**
2.0	Perfect independence – no autocorrelation (complete randomness)
1.5 - 2.5	Apparent independence (almost total randomness) – probably no autocorrelation
1.0 - 1.5 or 2.5 - 3.0	Some possibility of independence (considered a grey area concerning randomness)
0.0 -1.0 or 3.0 - 4.0	Probability of autocorrelation or serial correlation (non-randomness)

Source: Murphy (1989).

4.5.6 Descriptive statistics – frequencies

By examining the frequency of the variables, a feel for the dataset can be obtained. The sales are spread fairly evenly across 1994 to 1997, with 4 per cent fewer sales in 1995 and 1998. The bulk of the houses in the Newlands area were built in the 1960s (36 per cent), and the balance spread across the 1970s and the 1980s.

Most houses are in average condition (68 per cent), and constructed with a weatherboard exterior (65 per cent) and an iron roof (62.5 per cent). This was the most popular building style for the period through the 1960s and 1970s, so is consistent with the indicated age of the houses in the area.

The average size of the houses, based on the floor area rather than number of bedrooms, is between 101 and 150 sqm (56.2 per cent). If the area below 100 sqm is added in, this raises the percentage of houses under 150sqm to 70%.

Table 4-9 Frequencies of each variable

Roll	**Frequency**	**Roll**	**Frequency**
16710	44 (2.3%)	16730	107 (5.6%)
16719	207 (10.9%)	16740	104 (5.5%)
16720	33 (1.7%)	16760	469 (24.7%)
16721	163 (8.6%)	16770	329 (17.3%)
Sold 1994	401 (21.1%)	Sold 1995	309 (16.3%)
Sold 1996	357 (18.8%)	Sold 1997	392 (20.7%)
Sold 1998	315 (16.6%)	Sold 1999	121 (6.4%)
Built 1910s	21 (1.1%)	Built 1920s	16 (.8%)
Built 1930s	26 (1.4%)	Built 1940s	45 (2.4%)
Built 1950s	183 (9.6%)	Built 1960s	681 (35.9%)
Built 1970s	350 (18.4%)	Built 1980s	312 (16.4%)
Built 1990s	228 (12%)	Unknown age	33 (1.7%)
Average Condition	1302 (68.6%)	Fair Condition	75 (4%)
Poor Condition	11 (.6%)	Unknown Condition	12 (.6%)
Excellent condition	495 (26.1%)	Brick Exterior	51 (2.7%)
Aluminium exterior	8 (.4%)	Weatherboard Ext	1237 (65.2%)
Plastic exterior	7 (.4%)	Stone Exterior	5 (.3%)
Fibrolite exterior	442 (23.3%)	Roughcast exterior	68 (3.6%)
Concrete exterior	6 (.3%)	Unknown cladding	71 (3.7%)
Tiled roof	661 (34.8%)	Fibrolite roof	13 (.7%)
Malthoid roof	8 (.4%)	Unknown roof	27 (1.4%)
Iron roof	1186 (62.5%)		
Floor area Under 100sqm	430 (22.8%)	Floor area 101-150sqm	1,058 (56.2%)
Floor area 151 – 200sqm	300 (16%)	Floor area 201 – 250sqm	67 (3.5%)

Floor area Over 251 sqm	28 (1.5%)		

4.5.7 Summary

The results from the regression analysis has a clear indication that the sale price from 1997 to 1999 steadily increased and was a significant positive time period in the analysis. Sales subsequent to the removal of the HVOTLs in 1997 indicate a positive amount of $15,599, increasing to $30,020 in 1998 and again to $40,182 in 1998. Whereas sales from 1994, 1995 and 1996, prior to the removal of the HVOTLs, show a negative impact.

The location area 16710 has a negative impact; however, it is not in close proximity to the HVOTLs and is an area where there is lower cost housing. The number of sales from this area is very low, and it is not unexpected that this is a negative variable. The other location area 16780 that is showing a negative amount is in closer proximity to the HVOTLs; however, the houses are not within 200 metres and would not be a correlation to the HVOTLs.

The results from the regression equations subsequent to the removal of the HVOTLs are consistent in their results and conclusions will be discussed in the next chapter.

In the next section an analysis is carried out to determine any trends in the sales data over the period from the existence of the HVOTLs to 14 years after removal, to see at what point the stigma reduces.

4.6 SALES DATA ANALYSIS

4.6.1 Introduction

This section describes an analysis of the sales data that was carried out to determine the trends in sales information, and variations in the behaviour of buyers and sellers.

First, the median price for each area was determined with the data separated into two categories: before the removal of the HVOTLs, and after the removal of the HVOTLs. The standard deviations for each group were analysed, followed by determining which price band most sales occurred in.

Second, the data was then analysed in regards to: the average sale over the period 1996 to 2010; the change in land area; changes in length of time to sell; and average days to sell.

4.6.2 Data outliers and controls

To ensure the data reflect the market and do not have anomalies or outliers that may affect the results, the data was sorted and checked and the outliers were identified. Sales that were considered to be outliers were removed from the database. For example, data was removed for:

- A Newlands sale in 1999 for $30,000 with no floor area and no bedrooms recorded. The surmise is that this was a vacant site and included as a residential improved property in error.
- A sale from 1999 that was for $2.2m with no floor area or bedrooms recorded. As this was a very large block of land that would suit subdivision, the surmise is that this is a large block of land for subdivision, and therefore not a residential improved sale.
- A sale for $9,000 in Johnsonville East in 2001. The sale price is well below the median of $191,000, and therefore the surmise is that there was an error in inputting data for this sale.

For the calculations of the land area or floor area, any sales that have a 0 recorded were removed from that particular calculation in order to avoid distorted answers. They were left in for other calculations.

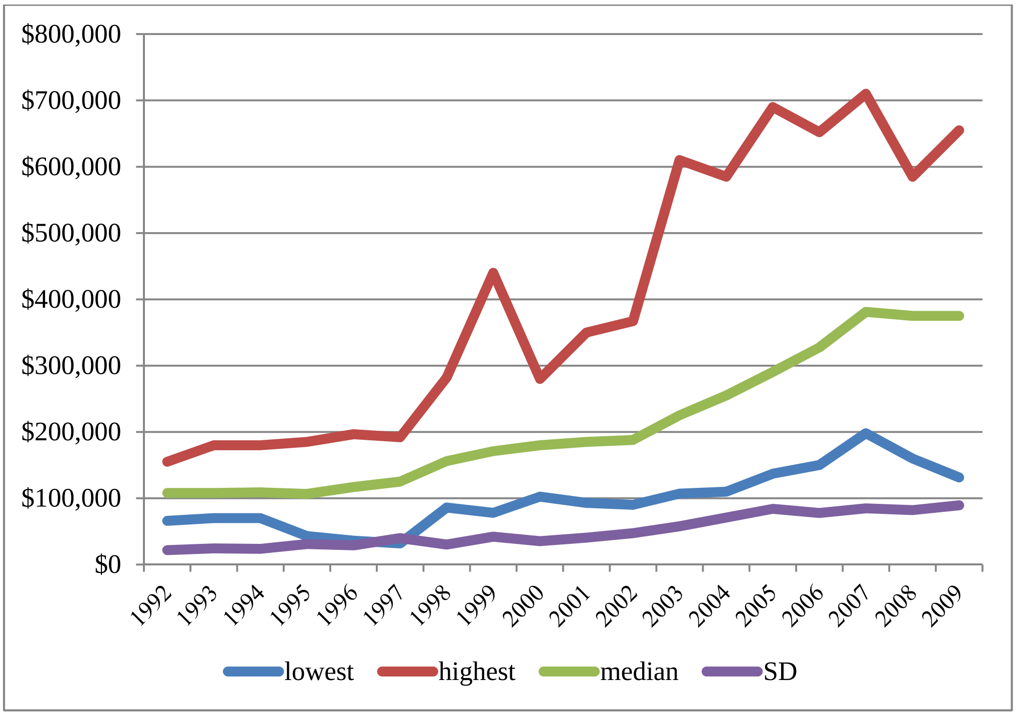
For the calculations related to the standard deviation calculations, these were calculated using the STDEV formula in Excel.

The contract agreement date is the date that was used as the reference point for the sale, rather than the list date.

4.6.3 Medians and band of sales

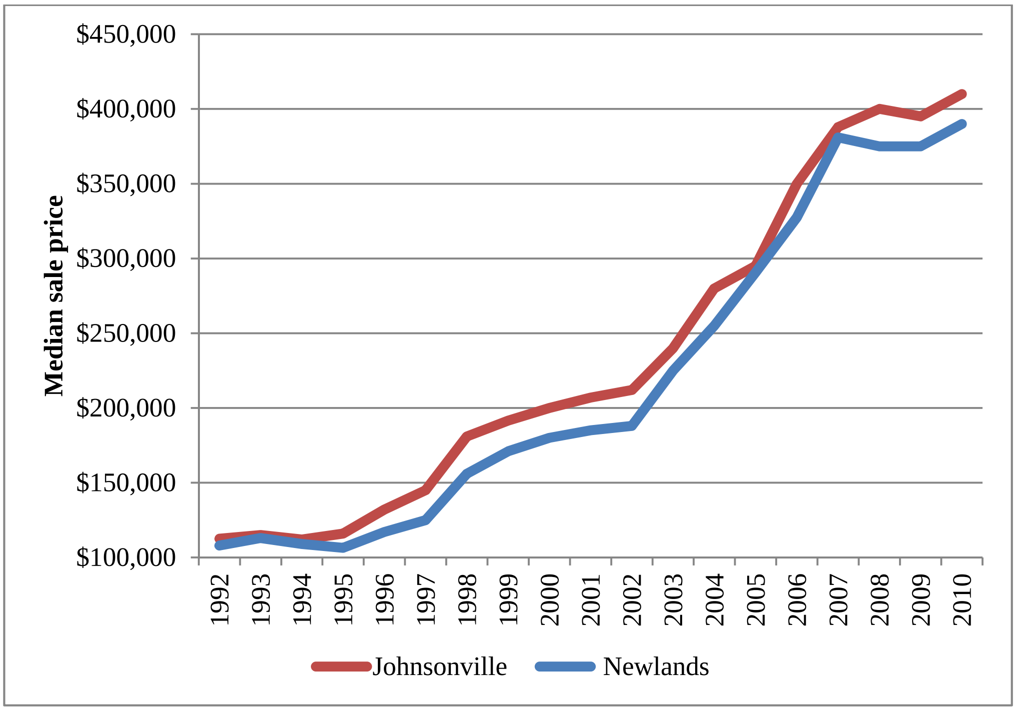
This section describes an analysis of the sales to determine whether, over the period before and after the HVOTLs are removed, there is a pattern within the data regarding the band within which sales have occurred. The medians and standard deviations within each year have been calculated to determine whether there are more sales within one bracket than another, and whether that changed when the HVOTLs were removed.

Figure 4-3 Newlands median and standard deviations 1992-2010



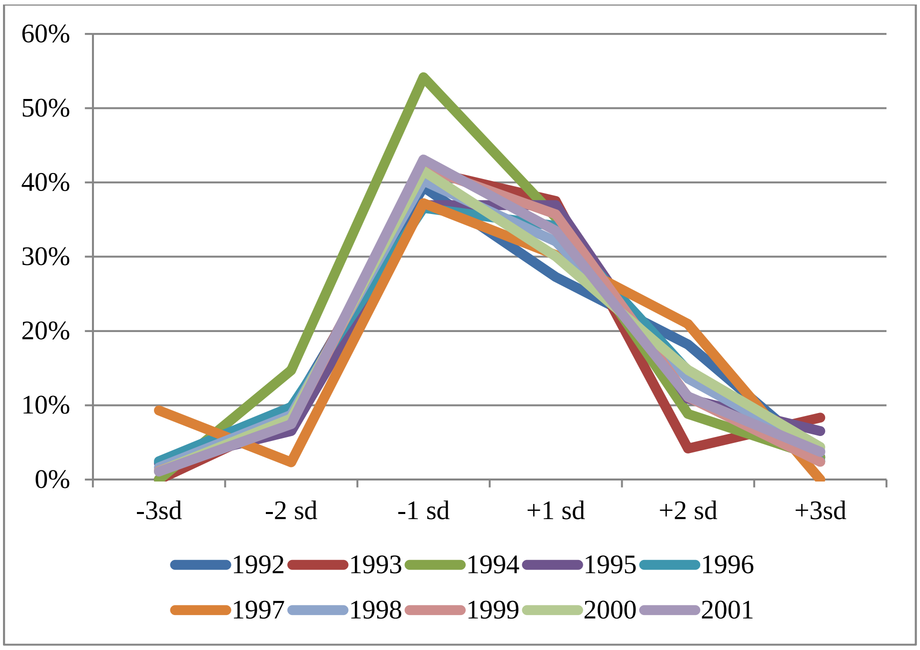
Of interest in the results is that the median remains reasonably constant through until 1997, after which the median steadily increases. (refer figure 4.4) The highest residential sale is also constant until 1997, and then increases sharply from 1997. However, when the medians and sales range are compared to the control area, it is seen that they are very closely related, with the control area (Johnsonville East) being consistently slightly higher.

Figure 4-4 Median sale comparisons from 1992-2010



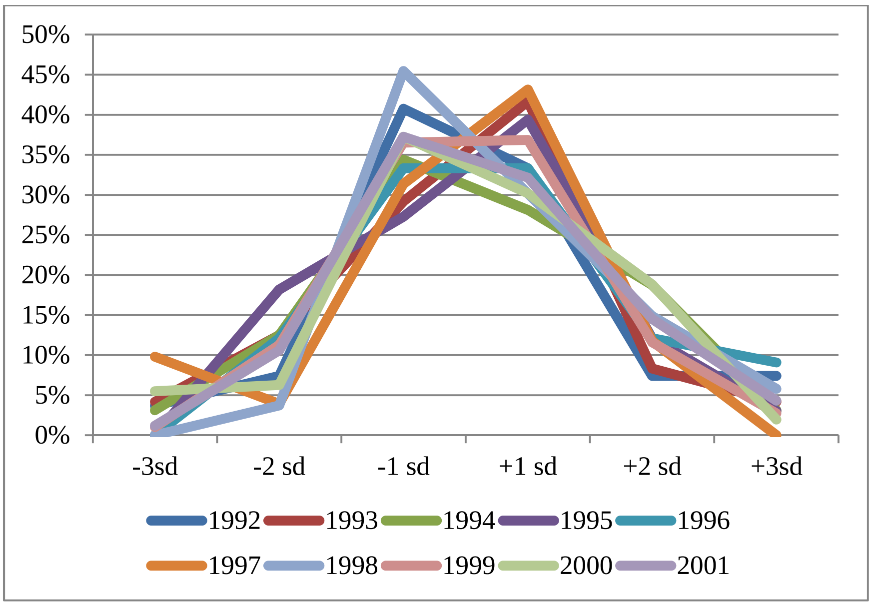
The standard deviations for the study area were further examined to determine in which group the bulk of the sales occurred across the timeframe (refer figure 4.5). In order to read the graph easily, the sales were restricted to the period 1992-2001. The percentage of sales is consistently shown as being one standard deviation below the median. This does not alter for the period following the removal of the HVOTLs. The following figure 4.6 illustrates the findings.

Figure 4-5 Standard deviations of percentage of sales for Newlands area



These standard deviations can be compared with the control area (refer figure 4-7) where there is clearly a more even split of sales, with some years being at minus 1 standard deviation while others are at plus one standard deviation. This is the pattern that would be expected when examining the sales over this period of time.

Figure 4-6 Standard deviations of percentage of sales for control area



4.6.4 Sales data comparison

In this section the sales data are analysed to determine patterns or trends over time. The study area (Newlands) is compared with the control area (Johnsonville East).

First, date are presented in Table 4-10 for the sale price, number of sales, average government valuation, average days to sell, and the comparison of list price against sale price. The government valuation has been included as in the New Zealand market it is an influencing variable for buyers.

Table 4-10 Sales data comparison for period 1996 -2010

	Newlands 1996	**Newlands 2010**	**Comparison increase**
Average Sale Price	$118,159	$417,565	353%
Total number of sales	187	133	
Average Government Valuation	$127,194	$403,814	317%
Average days to sell	83	73	13% shorter
List price against sale price	94.92%	99.7%	
	Johnsonville 1996	**Johnsonville 2010**	**Change 1996/2010**
Average Sale Price	$143,621	$421,090	293%
Total number of sales	242	141	
Average Government Valuation	$131,840	$414,120	314%
Average days to sell	50	103	52% longer
List price against sale price	96.78%	99.1%	

The control area (Johnsonville East) has also been analysed to determine whether the study area (Newlands) is showing patterns that are consistent with the overall market, or whether there is something different happening in this area. Comparisons between the two areas and across the timeframe have been carried out to identify any trends. The difference between Newlands and

Johnsonville East across the same time periods has been broken down in the following table 4-11and then discussed.

Table 4-11 Comparison between the Newlands study area and the control area

	1996	**2010**
Average Sale Price	Newlands 17.7% less	Less than 1% difference
Total number of sales	24% less in control area	Newlands 6% less
Average GV	Newlands 3.5% lower	Newlands 2.5% lower
Average days to sell	Newlands 66% longer	Newlands 70% quicker
Land area	Newlands 9% smaller	Newlands 12% larger

The above figures in table 4.11 make an interesting comparison between the two locations over a long period of time. The figures can also be further analysed to see at what point the market shifted.

The average sale price in Newlands has increased by an additional 60 per cent against Johnsonville East over the 14 year period (1996-2010), with the first four years showing a 17 per cent increase and then steadily increasing. Over this period Johnsonville East has increased by 293 per cent compared to Newlands, which increased by 353 per cent. This is a very large increase and reflects a significant change in the price bracket for the study area over this time frame.

The study area was taking 66 per cent longer to sell than the control area at the time that the HVOTLs were removed in 1996. However, four years later, in 2000, time to sell had reduced to only 4 per cent longer. This is explained later in this chapter when the results are individually analysed.

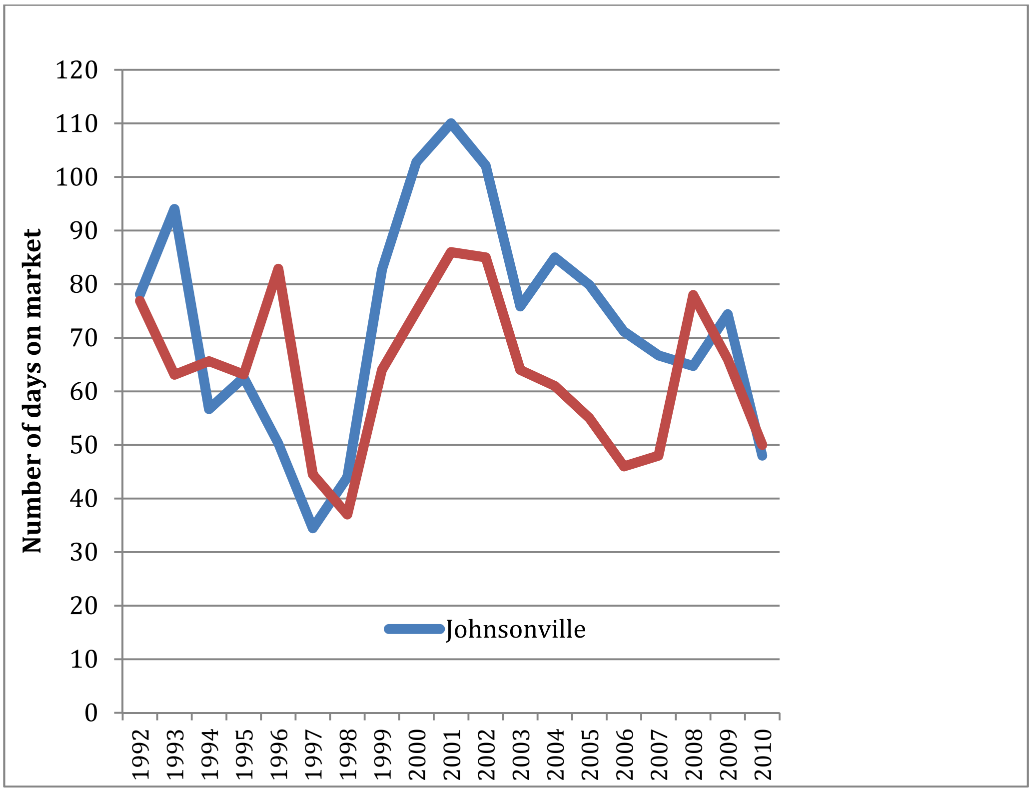
4.6.5 List price against sale price

Both time periods have a very close relationship between list price and sale price. The list price is around 3 per cent lower than sale price in 1996 compared to less than 1 per cent in 2010. This is a small variation that does not provide any guidance other than that buyers may have had less negotiating power in 2010.

4.6.6 Average days to sell

In 1996, Newlands properties were selling at a rate that was 66 per cent slower than in the control area – Johnsonville East. This levelled out in 1998. By 2010, it was taking 70 per cent longer in Johnsonville East. These figures can be explained by the number of houses on the market. When there are more houses on the market they will take longer to sell. We also need to be mindful that in 2010 the New Zealand economy was not in a strong position and houses were taking longer to sell.

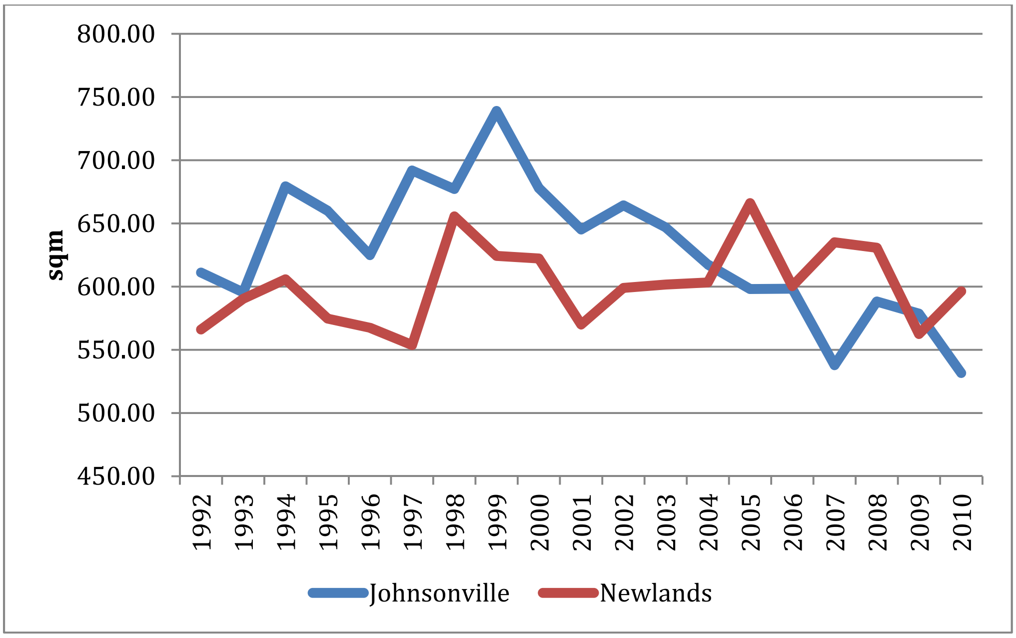
Figure 4-7 Average number of days on the market 1992-2010



4.6.7 Changes in land size

In 1996, land area was 9.2 per cent smaller in Newlands than in the control area. This changed to 12 per cent larger than the control area by 2010. However, looking at the land areas for the study and control areas in isolation, it can be seen that the land area in the control area was quite large in the 1990s and reduced in the 2000s. In comparison, the study area stayed reasonably similar with a 5% increase over the same period (refer figure 4-9). The changes in land area can also be explained in that the control area had new subdivisions and, with a hilly terrain, the section sizes are expected to be somewhat larger than what would be found in a new subdivision on flat terrain.

Figure 4-8 Average land area 1992 – 2010



4.6.8 Limitations

The number of sales provided by Real Estate New Zealand for both study and control areas is lower than expected for the period prior to 1996. This is due to the lack of data collected by Real Estate New Zealand prior to 1996. The

Headway NZ database represented a truer reflection of sales levels; however, the Headway database does not include the list price or number of bedrooms.

4.6.9 Summary

The sales data provide an understanding of the market and the changes to the average sales price, land area, number of bedrooms, and the average days to sell.

The average sales price shows a substantial increase for the Newlands area compared to the control area of Johnsonville East. Over the period 1996-2010, the Newlands area increased by 293 per cent compared to the Johnsonville area at 353 per cent. This indicates a much sharper, 60 per cent increase in sale price in Newlands.

Over the same period, the average land area for each lot remains fairly constant in the study and control areas, with the control area (Johnsonville) having larger lot sizes. This begins to change in the early 2000s when more subdivisions were opened up within the study area.

Until 1997, the number of days on the market is consistently higher for the study area up. From 1997, the trend changes to selling at a consistently faster rate. This is consistent with the sales information, with sales prices increasing from the 1997 period onwards. As properties sold more quickly, the prices also increased.

In the next section, the demographic trends will be analysed to determine changes within the neighbourhood after the removal of the HVOTLs.

4.7 DEMOGRAPHIC CHANGES

In this section the location attributes will be analysed. The location attributes of any neighbourhood are influenced by its demographic profile.

Demographics influence the desirability (or otherwise) of an area and consequently alter the demand for housing in that area.

In this section, the demographics are presented for the period before the HVOTLs were removed, and compared to the demographics of the neighbourhood after the HVOTLs were removed.

The demographics are taken from New Zealand census data. A census is carried out in New Zealand every five years. The census requires every person living in New Zealand on the specified date to complete the census survey. The requirement extends to all residents and tourists in the country on that date. The last census was due on 8 March 2011; however, no census was carried out on that date due to the national state of emergency relating to a devastating earthquake, which occurred in Christchurch on 22 February 2011, causing fatalities and widespread damage. The next census is due to take place in March 2013. Consequently, census data available for this analysis were from March 1991, 1996, 2001 and 2006. This provides for two sets of census data prior to removal of HVOTLs, and two sets of census data after their removal.

The boundary maps cannot be confirmed for the maps in 1991 and 1996, as they are not displayed within the Statistics New Zealand chart; however, the census refers to Newlands East, and Newlands South, which is the same as the reference for the 2001 and 2006 census. There is no Newlands West as these figures are referred to as Johnsonville East. It is the Johnsonville East area that forms the case-study control area.

The display of information is different between the four census dates, with material in 1991 and 1996 being provided in an Excel table format, whereas in 2001 the format was changed to an interactive online summary displayed in PDF graphs and summaries.

4.7.1 Population

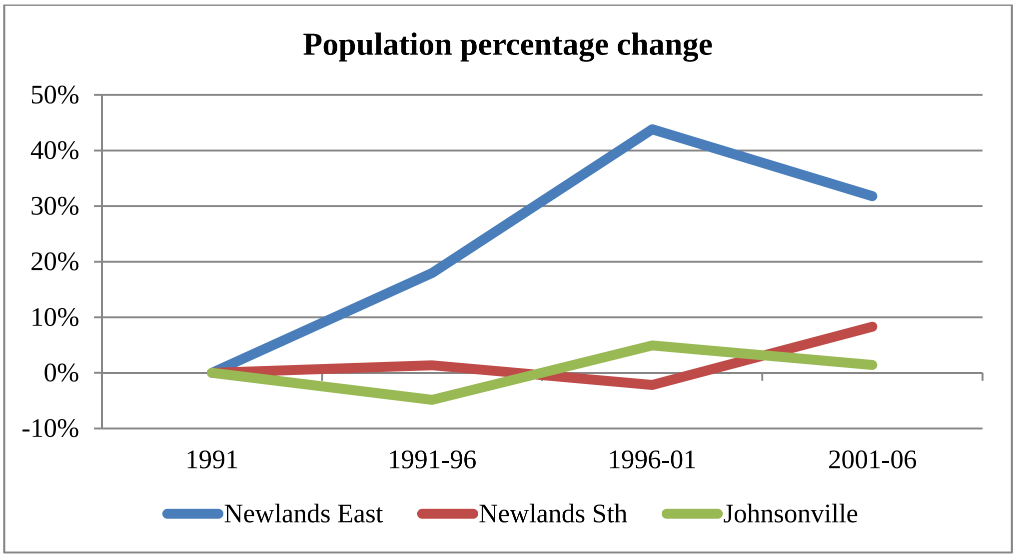
The first breakdown is of the population numbers (refer table 4-12). The population has sharply increased in the Newlands East area with an increase of 120 per cent over the 15 year period. This is not unexpected as there were new subdivisions in the area. The Newlands South area increased by 8 per cent; this is also not unexpected as this part of Newlands was already developed. Only infill housing was possible rather than new subdivisions.

Table 4-12 Population changes over census dates 1991 – 2006

	March 1991	March 1996	March 2001	March 2006
Newlands East	267	315	453	597
Newlands South	3,282	3,327	3255	3525
Johnsonville East (control area)	1914	1821	1911	1938

The following figure 4-10 shows the percentage change in population in the three areas over the time periods. The graph clearly indicates the large percentage increase in the Newlands East area, as discussed above.

Figure 4-9 Population change over census dates 1991 – 2006



4.7.2 Median personal income

The median personal income is a reflection of the wealth of the residents within the areas. A comparison across the years is drawn in order to determine whether there has been a change between the study areas and the control area of Johnsonville East. From the below figure 4-13 it can be seen that the Newlands South and the control areas have increased at a very similar rate with only 1.2 per cent separating them. The Newlands East area is to the north end of the former location of the HVOTLs and has higher value housing due to the view of the harbour. Newlands East starts with a higher median personal income than the other two areas but growth in this measure does not keep pace with the other two areas. However, it is noted that by 2006 the median personal income for this area is the same as the control area (Johnsonville East) at $34,700.

Table 4-13 Median personal income changes over census dates 1996-2006

	March 1996	March 2006	Percentage change
Newlands East	$29,676	$34,700	16.9%
Newlands South	$22,671	$32,000	41.1%
Johnsonville (control area)	$24,381	$34,700	42.3%

4.7.3 Dwelling tenure

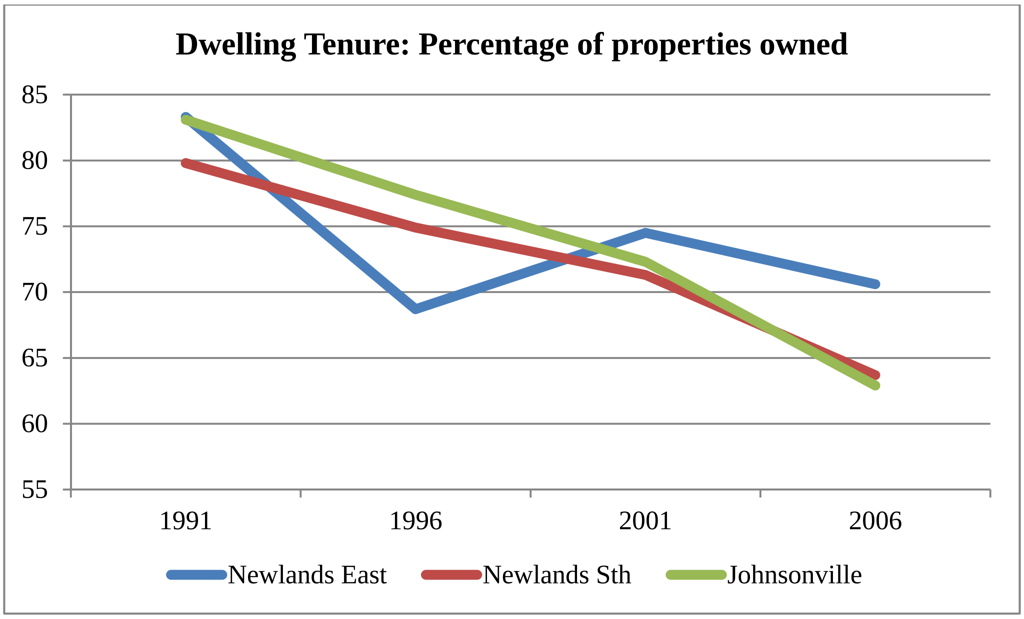
In this section the dwelling tenure is analysed to indicate whether home ownership is increasing in the study and control areas or whether properties are predominantly investment properties that are rented. The high home ownership rates in all three areas in 1991 reflects the New Zealand market, which has an owner occupier rate that is amongst the highest in the world (Hargreaves 2001). This census data clearly shows a downward trend in owner occupier rates in all areas, which is consistent with the rest of New Zealand. However, the study area shows a dip in 1996 and then increases to a higher level than the control area in the 2001 and 2006 census years. This indicates a more stable housing environment with fewer people renting.

Table 4-14 Dwelling tenure changes over census dates 1991 – 2006

	March 1991	March 1996	March 2001	March 2006
Newlands East	83.3% owned 26.7% rented	68.72% owned 31.28% rented	74.5% owned 25.5% rented	70.6% owned 29.4% rented
Newlands South	79.8% owned 20.2% rented	74.95% owned 25.15% rented	71.3% owned 28.7% rented	63.7% owned 34.3% rented
Johnsonville (control area)	83.1% owned 16.9% rented	77.43% owned 22.57% rented	72.3% owned 27.7% rented	62.9% owned 37.1% rented

The above information in table 4.14 has been graphed below in figure 4-11 to show the percentage of properties that are owned within the areas.

Figure 4-10 Dwelling tenure changes over census dates 1991 – 2006



4.7.4 Summary

The demographic data is extracted from the census data collected every five years by Statistics New Zealand. A limitation with this data is that the meshblock is quite large for all areas and therefore provides an overview of the total area rather than the immediate corridor where the HVOTLs are located.

However, the hypothesis is that the whole area is altered following the removal of the HVOTLs.

In summary, the Newlands East population has increased by 40% in the period after the HVOTLs were removed. With the removal of the HVOTLs, land then became attractive for development and brought an increase in population. There was also a change in the Newlands East regarding the balance between owner occupied and rental properties. Johnsonville East (the control area) has shown a steady decline in the number of properties that are owned compared to the number that are rented. This trend is in line with the total New Zealand figures.

Newlands South was slightly below the Johnsonville figures, with fewer owner occupied houses. This trend has changed with the removal of the HVOTLs and Newlands South is now equal to the control area, indicating that more people are now owning in the area rather than renting.

In the next section the repeat sales are analysed to determine trends over the time period based on case-studies of properties in close proximity to the HVOTLs.

4.8 REPEAT SALES ANALYSIS WITH CASE-STUDIES

4.8.1 Introduction

In this section the repeat sales will be analysed by using case-studies both within the impacted area and also a control area.

As the regression analysis showed that only those properties in very close proximity were affected, it was important in choosing the case-study properties that they were also in very close proximity to a tower. Close proximity for the purposes of this study is within fifty meters.

Six properties were chosen that have repeat sales across the period before and after the tower and line removal. To carry out the analysis, case-study properties were identified that previously was adjacent to a tower. This has narrowed the case-study options substantially; however, it is important that the properties were adjacent to a tower.

The condition of the building, the construction materials, and the age were obtained from the Government Valuation database. As the properties within the effected sales group all have a weatherboard exterior, the control group was also chosen to exclude brick or plaster exterior houses. This selection filter prevents any bias that may arise due to buyer perceptions of building materials changing over time.

The repeat sales were identified for the period between 1993 (before the HVOTLs were removed) to 2009. The sales were obtained from the Headway New Zealand database, which includes all sales for the area.

4.8.2 Study area property 1: 37 Sunhaven Drive

The first case-study property is situated at 37 Sunhaven Drive. The tower was previously situated immediately adjacent to the northwest side of the property. There is a view across the valley to the east, which the tower would not have obstructed. However, the approach to the house was past the tower, meaning the tower was very visible. The tower would have cast a shadow over the house throughout the afternoon. The area where the tower was previously situated is currently vacant and is judged to be approximately 300sqm. On 18 July 1995, the property was sold for $91,000. Floor area was 80sqm with a land area of 392sqm. The property was built in the 1980s so was approximately ten years old at the time of sale. The house construction is weatherboard exterior with a tile roof and the condition was classed as average. On 10 August 2009, the property sold again for $271,500. This was an increase of 198 per cent over the 14 years since the last sale. This increase equates to 14.1 per cent per annum over the period.

Figure 4-11 37 & 39 Sunhaven before Tower removed

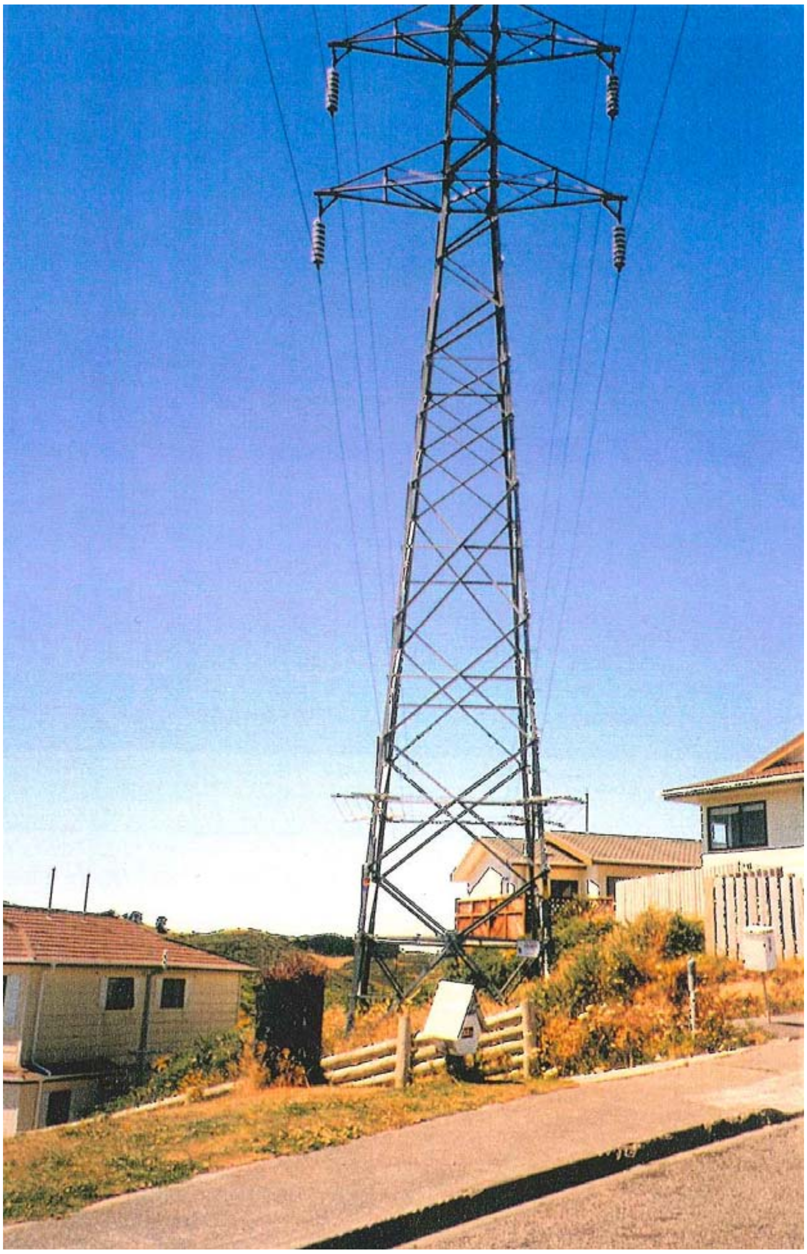


Figure 4-12 37 & 39 Sunhaven after tower removed

4.8.3 Study area property 2: 39 Sunhaven Drive

The second case-study at 39 Sunhaven Drive is next door to the first case study property. As this is a rear section, it is situated directly behind number 37 and therefore the tower was situated on the west side of the house. The tower was to the rear of the house, with the view to the valley on the east and north. Therefore, the tower would not be directly visible from the living areas of the house. The property sold a number of times before the tower was removed. On 10 June 1994, it sold for $87,000. On 15 August 1996, it sold for $97,000. Then on 5 April 2005, it sold for $226,500. The floor area is 80sqm with a land area of 767sqm. The property was also built in the 1980s. The construction of the house is weatherboard exterior with a tile roof and the condition of both is classed as average. These increases equate to 14.7 per cent per annum over the nine-year period in which the three sales occurred.

4.8.4 Study area property 3: 6a Sunhaven Drive

The third case-study is located at 6a Sunhaven Drive. This property is facing the Sunhaven Drive and the tower was located directly to the rear. This property is situated on the ridge with a very good view of Wellington Harbour. However, the tower was previously positioned between the house and the view. The floor area is 140sqm with a land area of 710sqm. The property was built in the early 1900s so would have been one of the original properties in the area. The house is constructed of weatherboard exterior with iron roof. At the initial sale in 1993, the exterior condition was listed as fair, and at subsequent sales exterior condition was upgraded to average. From the photos of the property it is suspected that the exterior weatherboards were upgraded between the sale in 1993 and subsequent sale in 2003, and the property appearance was modernised between the sales. On 19 September 1993, it first sold for $103,000. The next sale was not until 17 July 2003, when the sale price was $240,000. The property was later sold on 26 March 2008 for $415,550. As the period of change between 1993 and 2003 is the period of interest, The analysis was completed using the sales data for 1993 and 2003, which gives a change of 13.3 per cent per annum over ten years.

4.8.5 Study area property 4: 20 Somers Crescent

The fourth case-study is located at 20 Somers Crescent. This property is approximately 50 metres from where the tower was located. The tower was located to the south. However, the lines would not have affected the view directly as the lines were in line between the house and the view of the harbour. From the living areas the transmission lines would have dominated the view. The tower would have been very visible from the back yard. The house was constructed in the 1970s with weatherboard exterior and iron roof. The house is 160sqm on 723sqm of land. In July 1995, the property sold for $147,000, and at that time the property was considered to be in average condition for the exterior and good for the roof. The property then resold in March 2001 for $243,000, and at that point was considered to be in average condition all around. The repeat sale shows an increase of an average of 10 per cent per annum over the six year period between the two sales.

4.8.6 Study area property 5: 37 Edgecombe Street

The fifth case-study is located at 37 Edgecombe Street. The property faces Edgecombe Street and the tower was previously located to the rear. As with the next case-study, the tower was very visible from the street and seemed to rise up from the house. The house is 220sqm on 443sqm of land. Both subject 5 and 6 had the tower behind them. The tower was located in an adjoining public reserve. With the tower removed this land has been developed. Three houses now occupy this land, which would affect the privacy that was previously enjoyed. The house was built in the 1970s and was listed at the first sale (prior to removal) as being in good condition. Condition was reduced to average on the subsequent sale. The construction of the house is weatherboard with an iron roof. The earlier sale was on 5 September 1995 when the property sold for $160,000. The next sale was three years later, on 14 August 1998, when the property sold for $177,500. The latest sale was on 5 November 2009 when the property sold for $405,000. The increase between the 1995 sale (with the tower) and the 1998 (without the tower) was 11 per cent, which breaks down to 3.66 per cent per annum.

4.8.7 Study area property 6: 31 Edgecombe Street

The sixth case-study is located at 31 Edgecombe Street. This property is adjacent to 37 Edgecombe Street. It faces Edgecombe Street and the tower was previously located to the rear. Unlike the other case-studies, this property had no view of the harbour or valley, and the tower was located on the ridge running behind the property. This caused the tower to have a significant visual impact from the street as its base sat above street level. The tower would have cast a shadow over the house in the morning, as it was located to the east, and would have been very visible from the back yard. The house is 160sqm and the lot size is 511sqm. The house was built in the 1970s. At both sale dates it was listed as being in average condition with the construction being weatherboard with an iron roof. The first sale was on 6 July 1994 when the property sold for $129,000. The next sale was on 5 January 2003 when the property sold for $230,000. The increase between the two sales is 78% over the nine years, or 8.66% per annum.

4.9 CONTROL REPEAT SALES

4.9.1 Control area property 1: 50 Chapman Street

The first control case-study property is 50 Chapman Street. This property is still within the suburb of Newlands and also has a nice view over the valley. The house is two storey and built with a weatherboard exterior and iron roof. The house was constructed in the 1970s and has a floor area of 220sqm on a land area of 433sqm. The Government Valuation (GV) has the property recorded as in average condition. The first sale occurred on the 24 May 1995 when the property sold for $198,000. At the later sale on 19 June 2003 the property sold for $295,200. This represents an increase of 49% over the period, or 6.1% per annum.

4.9.2 Control area property 2: 10 Fitzpatrick Street

The second control property is at 10 Fitzpatrick Street. It is a single storey detached house with a weatherboard exterior and iron roof. This property has a limited view across Newlands and was constructed in the 1960s. The floor area is 180sqm with a land area of 541sqm. The Government Valuation records the property as being in average condition. At the first sale on 9 December 1995, the property was sold for $102,000. At the next sale, on 2 January 2005, the property was sold for $287,500. This represents an increase of 182% over the period, or 18.2% per annum.

4.9.3 Control area property 3: 17 Fitzpatrick Street

The third control property is at 17 Fitzpatrick Street. This property sold five times over an eight year period. The house is two storey and a slightly unusual style for the suburb. The floor area is 110sqm with a land area of 458sqm. The house was constructed in the 1970s with a weatherboard exterior and iron roof, and is considered to be in average condition. The first sale within the study period occurred on 9 March 1994 when the property sold for $128,000. The second sale was on 13 June 1995 when the property sold for $140,000. The third sale occurred on 22 June 1997 when the property sold for $153,300. The fourth sale was on 24 June 1998 when the property sold for $166,500. The fifth sale occurred on 6 February 2002 when the property sold for $188,500. It is unusual to have five sales in an eight year period; however, the sale price data provides a good base for observing the movement in prices.

4.9.4 Control area property 4: 54 Ruskin Road

The fourth control property is at 54 Ruskin Road. This property is a weatherboard two storey house with an iron roof. The house was constructed in the 1960s with a floor area of 90sqm on a land area of 549sqm. The property was listed as being in average condition. At the first sale on 31 August 1995 the property was sold for $101,500. The property then sold again on 25 March 1999 for $132,500. The third sale occurred on 23 August 2007 when the property sold for $350,000. The difference between the 1995 sale and the 1999 sale is 30% per cent, or 7.5% per cent per annum.

4.9.5 Control area property 5: 59 Ruskin Road

The fifth control property is at 59 Ruskin Street. This property is split level, weatherboard exterior with an iron roof. The house has a nice view across the Newlands valley. The house was constructed in the 1970s and is in good condition on the exterior and average condition for the roof. The first sale was on 13 August 1994 when the property sold for $112,000. The next sale was on 1 April 2001 when the property sold for $185,000. The difference over the seven years between the 1994 sale and the 2001 sale is 65%, or 7.22% per annum.

4.9.6 Control area property 6: 10 Salford Street

The sixth control property is at 10 Salford Street. This property is a more modern design. It is a two storey weatherboard house with an iron roof. It has good distant views of the harbour and across the valley so is similar to the study area. The house was constructed in the 1970s and is in average condition. The floor area is 170sqm on a land area of 499sqm. The first sale was on 24 February 1995 when the property sold for $157,500. It resold on 9 September 2004 for $310,000. The difference over the nine years between the 1995 sale and the 2004 sale is 97%, or 10.7% per annum.

4.9.7 Repeat sales summary

The repeat sales for the study area were graphed and the trend line for each sale calculated. The same process was then repeated for the control area.

The repeat sales analysis shows that the beta for the study area properties is lower than the beta for the control area properties. This means that the study area properties have moved in price at a lower rate than in the control area. This is in contrast to the average prices for the study area, which show the study area properties increasing at a higher rate. The following figures 4.13 and 4.14 illustrate the data.

Figure 4-13 Repeat sales - study area

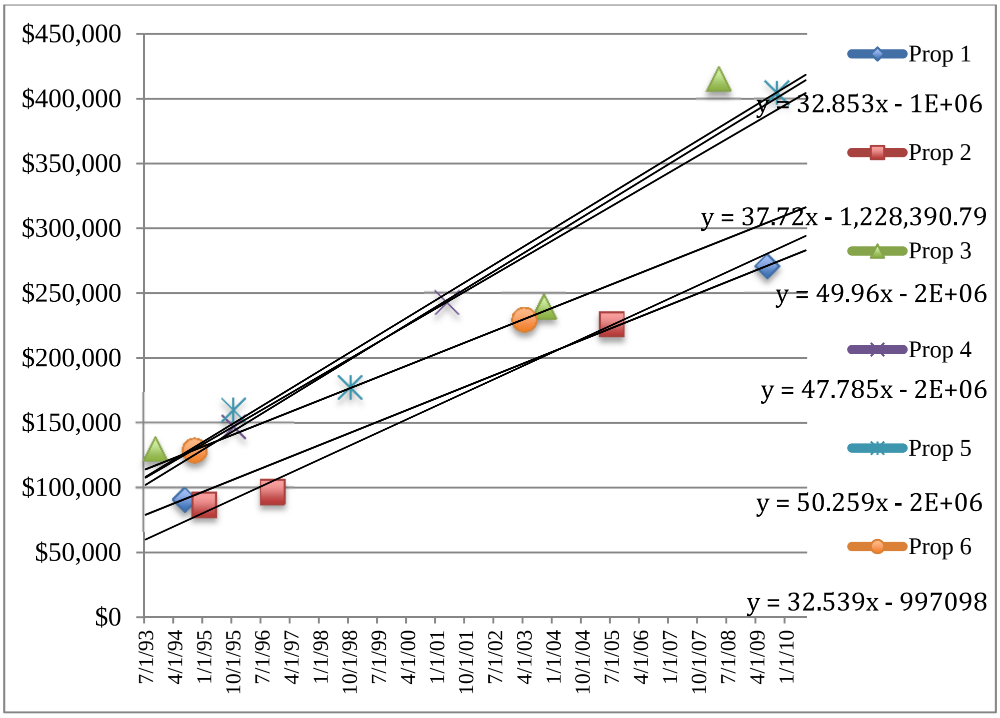
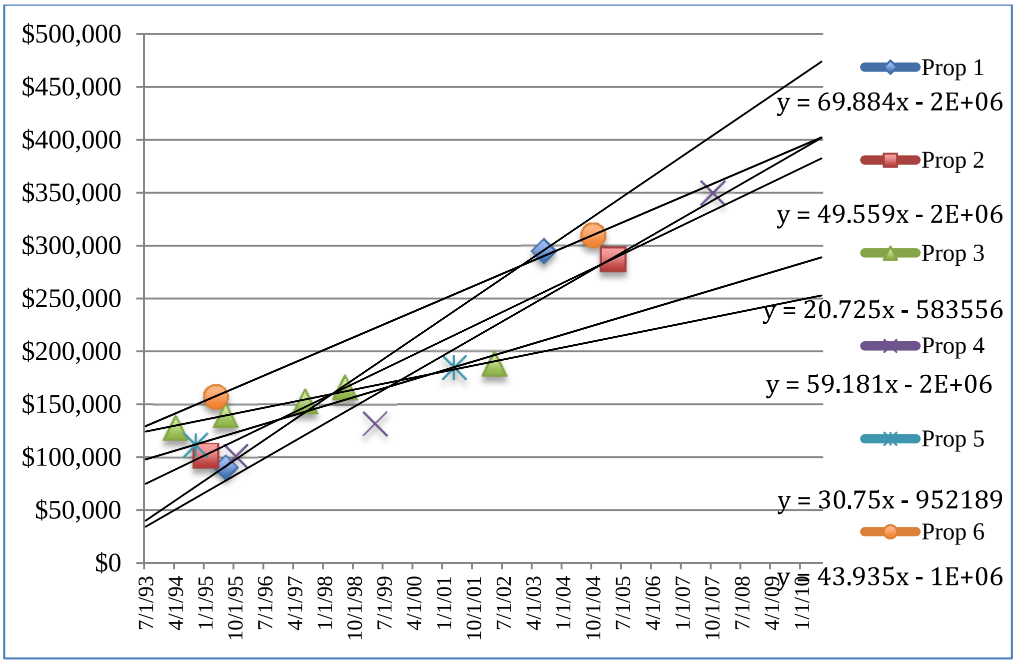


Figure 4-14 Repeat sales - control area



4.9.8 Summary

This chapter has outlined and discussed the results from the analysis of the data that is the basis of this thesis. The analysis allowed findings as follows:

1) Regression analysis results **before** the HVOTLs were removed
2) Regression analysis results **after** the HVOTLs were removed
3) Sales data analysis to determine patterns of change in property size, length of time on market, changes in sale price, and number of sales.
4) Analysis of demographic changes in the area
5) Repeat sales analysis with case-studies.

The next chapter outlines the conclusions that can be drawn from the results outlined in this chapter.

Chapter 5: Conclusions

5.1 INTRODUCTION

In the previous chapters the literature was reviewed, the methodology was described, and the case-study background was outlined, followed by a discussion of the results.

In this chapter, the conclusions will be presented along with future research options. Limitations encountered within this research will be presented.

5.2 CONCLUSIONS

5.2.1 Regression analysis results before the HVOTLs were removed

The results show that the effect of having a tower close to a particular property is significant with a negative effect on sale price of 27% at 10-15 metres from the tower, decreasing to 5% at 50 metres. This effect diminishes to a negligible amount at a distance of 100 metres. This result therefore affects a very narrow corridor of properties through the neighbourhood.

The impact of the HVOTLs on sale prices is analysed by applying a variable for the lines and a variable for the towers. The lines in the Newlands area have a minimal negative effect on sale price, which is not statistically significant. It is concluded, therefore, that lines did not have an impact. The towers have a negative effect on sale price at a close distance, which reduces rapidly from 50 metres to a negligible amount at 100 metres.

5.2.2 Regression analysis results after the HVOTLs were removed

The HVOTLs were removed in 1996 and the analysis of the sales indicates a marked change in the sales price for the area from the period 1997 onwards. Sales in 1994, 1995 and 1996 – prior to the removal of the HVOTLs – show a negative impact from proximity to HVOTLs. The results from the analysis show that following the removal of the HVOTLs in 1996, a steady increase in value occurred over the period 1996-1999. Sales subsequent to the removal of the HVOTLs indicate a positive increase in sales of $15,599 for 1997, $30,020 in 1998, and $40,182 in 1998.

The results from the control area, which is located to the west of Newlands, but officially called Johnsonville East in the census material, present a very similar hedonic pricing model.

5.2.3 Sales data analysis to determine any patterns of change

In this section the conclusions are discussed in relation to the sales data and trends. The sales data were analysed in relation to changes in land size over the period, along with changes in building size, length of time on the market, changes in sale price, and any change in the number of sales.

The length of time to sell in the period prior to the removal of the HVOTLs was 66 per cent longer than length of time to sell in the control area. This reduces in the year following removal of the HVOTLs (1997) to 29 per cent. From 1998, property sells more quickly in Newlands than in the control area. By 2000, four years after the removal, the length of time to sell is consistently shorter in Newlands than in the control area, indicating that the stigma disappeared after two years. This conclusion needs to be read in conjunction with two other findings: first that there was an increase in sales prices after 1996, and second, after 1996 there were fewer houses on the market in the study area. Prior to, and including, 1996 there were more houses on the market in the study area (Newlands) than in the control area (Johnsonville East).

The land area in the study area was 9 per cent smaller in 1996 than land area in the control area. This consistently remained the case until 2005 when the results show land area in the control area as approximately 12 per cent larger. The conclusion has to be tempered with the knowledge that the study area land size has actually remained fairly constant, with only a 5 per cent increase in land size over the 18 years 1992-2010. At the same time, land sizes in the control area were quite large in 1992, with the average of 611sqm. This reduced to 531sqm in 2010, being a reduction of 15 per cent. No conclusion can be drawn from the land size in relation to the removal of the HVOTLs.

The sales information about changes in building size shows that in both the study area and the control area, the average house size of three bedrooms did not alter across the 18 year study period.

The change in sales price is the most informative statistic. Following the removal of the HVOTLs, prices in the study area of Newlands increased at a much faster rate than in the control area. From 1996 to 2010, sales prices in the study area increased by 60 per cent more than sales prices in the control area over the same time period.

In summary, the length of time to sell in the subject area dropped significantly over the two years following the removal of the HVOTLs. During that two year period, average sale price increased by 48 per cent, compared to the control area which increased by 35 per cent. Land area appears unaffected either before or after the removal of the HVOTLs. The number of bedrooms did not change over the two year period following the removal of the HVOTLs.

5.2.4 Demographic changes

The demographic profile of the study area was compared to the demographic profile of the control area, to determine any alterations in population, personal income levels, and the percentages of owner occupied properties and rented properties.

The demographic information was obtained from the New Zealand census database, which is updated every five years. The census information has defined boundaries, and the Newlands South and Newlands East meshblocks are the two areas traversed by the HVOTL corridor. The meshblock for Johnsonville East aligns very closely to the control area that has been used in the hedonic pricing model, and also aligns very closely with the area for which sales data was extracted.

Over the 15 year period 1991-2006, the census data show a sharp population increase in the Newlands East area. This increase is considered to be due to the opening of new land areas for subdivision which occurred after the removal of the HVOTLs. The control area and the Newlands South study area both show minimal population increases of 8 per cent for the period 1991-2006. This slower rate of increase is due predominantly to the lack of additional land in this area, meaning that only construction of infill housing could take place. In conclusion, the population changes cannot be inferred to be a result of the removal of the HVOTLs. The opening of land for subdivision in the area may have happened whether the HVOTLs were removed or not.

The percentage increase in median income levels is similar in the study area of Newlands South and the control area of Johnsonville East. The Newlands East area did not increased at the same rate. This slower rate of increase needs to be read in conjunction with the large population increase in the Newlands East area. The median income level is at exactly the same dollar amount as in the control area, even though it has not increased at the same pace.

The changes in dwelling tenure produced interesting results. There was a decrease in owner occupancy in 1996. However, following the removal of the HVOTLs, the rate then increases to a higher level than the control area in both 2001 and 2006 census years. This would indicate a more stable housing environment with fewer people renting.

In summary, the Newlands East population increased by 40 per cent in the period 1996 -2010 following the HVOTLs removal. With the removal of the HVOTLs, land that then became attractive for development, bringing an increase in population. There was also a change in the Newlands East area in regards to the balance between owner occupied and rental properties, with more people owning property.

5.2.5 Repeat sales analysis with case-studies

A selection of properties was chosen as case-studies to determine if there was a relationship or trend in the repeat sales over the period before the HVOTLs were removed and after they were removed. Repeat sales from 1992 to 2010 were analysed. All of the case-study properties are located within 50 metres of where the HVOTL towers were located. Properties within 50 metres were chosen as the regression analysis showed that prior to removal of HVOTLs, an impact on property value was evident only for those properties that were adjacent to, or up to 50 metres from, a tower.

The control case-studies were chosen from the control area of Johnsonville East. All case-study properties have similar construction of weatherboard exterior and iron roof, and are of a similar age.

The repeat sales trend line indicates a contradiction with the results from the changes to the average price for each area. The regression beta for the case-studies in close proximity to the HVOTLs shows that the sales prices in the study area increased at a slower rate than prices in the control area.

Further detailed analysis of sales data shows that case study control property number 1 in the control area may have undergone renovations over the period. Its resale price is considerably higher than for other case study properties in the control area; the resale price at first sale was the lowest price for the control group of case study properties, and the highest on its repeat sale. If this property is removed from the dataset and the average resale price is calculated for the five remaining properties in the control area, then the average is more consistent with the earlier findings in which the subject properties have moved at a faster rate.

5.3 SUMMARY

Previous sections in this chapter have outlined the conclusions drawn from each analysis. The first result presented was from a hedonic pricing model in the form of a multiple regression prior to the removal of the HVOTLs. This result showed a negative sale price impact of 27% on properties adjacent to the towers, reducing to 5% at 50 meters, and negligible impact from 100 meters. The lines themselves did not have an impact.

The second analysis was from a similar multiple regression analysis carried out on data related to the period following the removal of the HVOTLs. This result showed that houses sold in the study area in 1997, 1998 and 1999 were significant within the regression analysis, showing a positive impact. Those properties sold in 1997 recorded an increase of $15,599. This increased in 1998 to $30,020, and again in 1999 to $40,182. The analysis is also consistent with the findings from the regression analysis prior to the removal, in regards to a negative impact for sales prior to 1996.

The third analysis undertaken was of the sales data for length of time to sell, average land and building size, and average sale price. The results from this analysis show that the average time to sell in the study area reduced significantly over the two years following removal of HVOTLs, and average sales price increased by 13% over the control area for the same period. Land area and the number of bedrooms did not alter significantly as compared to the control area.

The fourth analysis undertaken was of the demographic profiles of the study and control areas. The results show that the Newlands East population has increased by 40% in the period following the removal of the HVOTLs. There was also a change in the Newlands East area, with a higher percentage of owner occupiers compared to the period before the removal.

The final analysis undertaken was of repeat sales in the study area. These results from this analysis are inconclusive. If all the case-study properties are included, the analysis shows that prices in the control area increased at a higher rate than the study area. However, one of the sales in the control area appears to be very influential and may have skewed the results; in 1996, prior to removal of the HVOTLs, it sold for a lower price than the other case-study properties in the control area, but then recorded the highest price for this group of properties after removal of the HVOTLs in 1996. If this property is removed then the results show that the affected study area has increased at a higher rate than the control area. A limitation is clear in that, due to the small number of repeat sales in the study area, when the equivalent number is selected in the control area, then they can be very influential.

5.4 RESEARCH QUESTIONS

The research questions as outlined in the first chapter can know be addressed.

1. *Does stigma related to HVOTLs create a negative impact on property values?*

a) *What is the effect on residential property values from stigma?*

Using the HVOTLs as a case study, it was determined that there was a negative price impact of 27 per cent for properties in close proximity to the towers, and that this impact reduced to 5 per cent at 50 metres, and was negligible at 100 metres.

b) *Are there changes within the neighbourhood demographics with the creation or removal of a stigma?*

The neighbourhood demographics changed predominantly in relation to the balance of owner occupied and rented property within the study area. On removal of the HVOTLs, the population became more stable with fewer property transactions and a higher proportion of owner occupied dwellings.

2. *Once the HVOTL structure has been removed:*

a) *How long does the stigma last for?*

Through the use of a case-study in an area where a set of HVOTLs was removed, the resulting stigma was analysed. The stigma remained for approximately three years as the market adjusted to the removal of the HVOTLs.

b) *Does the value difference from removing the stigma, vary from the adjustment that purchasers make when purchasing while the NIMBY structure is still in place?*

A negative impact of 27 per cent on sales price attributable to the NIMBY was evident for those properties in the study area that were adjacent to the towers; however, the negative impact reduced to 5 per cent at 50 metres. When the HVOTLs were removed, the whole area improved in value, not only those properties adjacent to the towers.

The repeat sales analysis was inconclusive about whether the value of properties in close proximity to the HVOTLs increased at a higher rate than the whole area after the removal of the HVOTLs.

3. *What is the most applicable method for the property Valuation profession, in valuing a NIMBY or stigma?*

   A multiple approach to the valuation is the most applicable method in valuing a NIMBY or stigma. The multiple regression analysis isolated the NIMBY variable; however, a more in-depth analysis of the sales and the neighbourhood demographics can determine changes in the wider area.

5.5 CONTRIBUTION TO LITERATURE

This research builds on the literature in relation to the effects of HVOTLs on property values. Importantly, this research adds to the knowledge about the effect of the stigma when the HVOTLs are removed, and how long this stigma lasts after removal.

The findings that contribute to the body knowledge are as follows:

- While the HVOTLs are in place, the impact on value is predominantly only evident for those properties that are in close proximity (up to 50 metres).
- On removal of the HVOTLs, the **whole** neighbourhood improves in value, with a significant increase over a period of 3-4 years after removal.
- Properties that were affected prior to removal do not show any greater increase in value than the rest of the neighbourhood.
- A higher level of owner occupation occurs after the removal of the HVOTLs as compared to higher levels of investment/rental properties before removal.

5.6 IMPLICATIONS FOR FURTHER RESEARCH

Further research topics were revealed while the research questions for this thesis were explored. These additional topics are:

- Does the impact on price vary according to height of towers or voltage of lines?
- Does the level of landscaping around the HVOTLs have an impact?
- Are some types of property more vulnerable to HVOTLs price impacts than others? For example, are impacts more evident for higher cost residential, agricultural, commercial, and industrial properties?

This research was based on a residential low to medium cost housing area. Future research could be carried out on medium or higher cost housing, which may identify a different effect from the HVOTLs, along with different attitudes, which will affect the length of time the stigma remains. It may be that people seeking to purchase property at the lower end of the housing market are prepared to offset one detrimental factor against another, which someone paying $1,000,000 for a house may not be willing to do as they have more options within the market.

Another direction for future research is to determine the length of time that stigma remains within different property markets, such as commercial, industrial or rural areas. These other areas may also identify different characteristics as being important in the value of the property.

The literature review revealed a Canadian study by DesRosiers (2002) that raised the question of whether the landscaping or colour of the towers could make a difference to the impact. Although DesRosiers raised the question, to date, it has not been answered or progressed by others.

5.7 LIMITATIONS

The research has a number of limitations, which need to be acknowledged.

The attitude of buyers to the presence of a transmission line may vary over time. This change in attitude may be due to new information regarding the health effects of the electromagnetic field produced by the transmission lines. If a buyer is convinced that transmission lines have a negative health or safety effect, it would be expected that their perception of what the property is worth will be altered. Alternatively if a conclusive report was to be issued stating there is no health risk, a whole new set of buyers would enter the market for that land near the lines and thereby affect the value. There have been various reports before and during the period that this study was undertaken about health effects, both implying there is an effect and disputing such an effect. However, the media and casual conversations can bring these up at any time. Therefore, it is extremely difficult to define a variable for this influence.

A methodology is needed that can incorporate variations in attitudes and in personal or social values. However, this is not possible here as attitudes can change daily if there is publicity about health effects, and this has not been taken into account in the hedonic pricing model.

A further limitation is around changes in consumer attitude to new technology, which may alter their acceptance or tolerance of the visual impact of the transmission corridor. Therefore, the impact of the transmission corridor on property value is subject to change (either positive or negative) according to changing attitudes.

The main limitation was the lack of properties sold directly under the line. These properties represented 4.5% of the total sales. If sales up to 50 metres were included, then this would represent 10% of total sales. This is an acceptable proportion; however, more sales would make for a more robust model.

A control area was used to compare with data from the study area. The control area was west of Newlands Road, which has no transmission line within 800 metres. A limitation occurred in selecting a control area, which has the same housing characteristics, land contour, age of housing and demographics. The control area chosen (called Johnsonville East in the New Zealand census data) has very similar housing characteristics and land contour, but borders on Johnsonville, which is a different suburb.

5.8 RESEARCH EXPERIENCE

5.8.1 Preparing for the doctorate

Preceding the doctorate thesis, the researcher undertook consultancy work for Transpower NZ, starting in 1993 in the Newlands area. Subsequently, in 2000, consultancy work was also carried out for Highbrook Ltd in the Auckland area where a hedonic pricing model was constructed, and an attitudinal study and a Contingent valuation (in the form of a Willingness to Pay analysis) were undertaken. This work was followed up in 2002 by an analysis of another area in Auckland, called Dannemora. In the Dannemora study, the HVOTLs had been removed. Lines had been placed underground by the developer so that the subdivision and shopping centre could be constructed. All areas produced a very similar result for the regression analysis on the presence of the HVOTLs. However, the hypothesis was that if the HVOTLs were removed, then the neighbourhood would change and the impact of removing them would be greater than the negative value that was attributed to them. This experience formed the impetus for this thesis, with the opportunity to study an established residential area from which HVOTLs had been removed, and to determine how long the stigma remained after removal.

5.8.2 Developing expertise

The researcher has presented eight papers through refereed journals, non-refereed journals and conference papers. The peer reviewed papers served to reinforce that the methodology is an acceptable method, and has been cited by international studies.

The report by Callanan (1994), and published findings (1995), has also been published in a book by Bond (2013). (Note that this book includes a chapter, which is a copy of the work by Callanan (1995), published without authors permission or acknowledgment. Action is currently underway to have this rectified.)

Furthermore, the conference papers and PhD colloquium to which this research has been presented have provided valuable feedback and a further insight into the topic. The researcher started this thesis part-time in 2000 through Massey University, NZ, under the supervision of Professor Anton Meister and Professor Bob Hargreaves. However, the researcher took a break from 2001, and returned to the research, and modified it in 2010, as part of this thesis.

The following is a list of research outputs from the research. Note that the author of this thesis was also previously known as 'Hopkins'.

2013 Callanan J.M. Contingent Valuation: How Accurate is it? ERES Conference, Vienna, Austria.

2013 Callanan.J.M. A Contingent Valuation approach to the Valuation of High Voltage Transmission Lines. PRRES conference, Melbourne.

2010 Callanan J.M. Are residents willing to pay for the removal of high voltage transmission lines from their neighbourhood? RICS Cobra Conference, Paris France.

2010 Callanan J.M An update on the latest literature - Effect of High Voltage transmission Lines on property Values, Pacific Rim Real Estate Conference, Wellington NZ. (non-refereed)

1999 Hopkins J.M 'Not in My Backyard' Syndrome: The Effect of NIMBYs on Residential Property Values. Australian Land Economics Review Volume 5 No 2 pgs 26-35

1995 Callanan J.M The effect of overhead transmission lines on property values: A statistical analysis. NZ Valuers Journal, June 1995, pgs 35 – 38

1995 Callanan J.M. Residential values beneath high tension power lines. NZ Property Investor, 7 August 1995, pg 5.

1995 Callanan. J.M & Hargreaves. R.V. The effect of high tension overhead transmission lines on property values. Presented and published, to the Pacific Rim Real Estate Society Conference, Melbourne Jan 1995. Presented by R.V. Hargreaves.

1994 Callanan J.M. Report to Transpower NZ.

5.9 SUMMARY

This chapter has presented the conclusions of the research, contributions to knowledge, the limitations of the research, and further research opportunities. The personal development of the researcher was also outlined showing expertise and new knowledge obtained in researching and writing this thesis.

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Appendices

Appendix A

Analysis of regression equations

The multiple regression analysis was carried out using a statistical analysis package called IBM SPSS. There are two different methods for variable selection: stepwise, and forced enter.

The stepwise method uses two other regression procedures, called forwards and backwards. At each step, the independent variable not in the equation, which has the smallest probability of F, is entered, if that probability meets the minimum value. This procedure is repeated for the next independent variable with the largest correlation, until they fail to meet the criteria and the procedure is terminated.
The forced enter method forces all variables into the equation.

Regression analysis is a least squares technique where the aim is to minimise the sum of the squared deviations between the predicted and actual values. The sum of squares can be illustrated by partitioning out the components.

SST = SSp + SSu

Where	SST	=	Total Sum of Squares
	SSp	=	Sum of Squares predicted or explained
	SSu	=	Sum of Squares residuals or unexplained

SSp is the variance explained, or in equation terms μ, whereas SSu is the variance that is not explained (for which another term is the residuals Y).

The equation, which produces the best line of fit, can be accomplished by relying on seven statistical tests. These include: the coefficient of correlation (r); coefficient of determination (r^2); t statistic; standard error of estimate; and f statistic. These five are 'goodness of fit' tests that are considered the primary statistical tests used to substantiate the most reliable multiple regression analysis equation. The supplementary statistical tests to check the stability of the equation are multicollinearity and the Durbin-Watson test.

Coefficient of correlation (r)

The coefficient of Correlation is a measure of the relationship between the independent and dependent variable. The coefficient of correlation is very similar to the coefficient of determination except that the latter is squared.

Coefficient of determination (r^2)

The coefficient of determination is a measure of the percentage of movement of the dependent variable that can be explained by the percentage movement in the independent variables, or how well changes in the independent variables explain the change in the dependent variable. This is expressed as r^2. An r^2 of .95 means that 95% of the total variation of the dependent variable can be explained by the regression equation. The r^2 value will range from zero to one.

$$r^2 = SSp/ SST$$

The value of r^2 is considered to be an optimistic estimate of how well the model fits the population, due to it being drawn only from a sample of the population.

An adjustment is therefore made to make an unbiased estimate of r^2. This is known as the adjusted r^2.

$$ar^2 = r^2 - (k-(1-r^2)/n-k-1)$$

Where

ar^2 = Adjusted r^2

k = number of independent variables

n = number of cases

T Statistic

The T statistic determines the significance of each coefficient of the independent variables in predicting the dependent variable. The T statistic can be positive or negative and indicates the number of standard deviations that the particular coefficient is away from zero.

$$\text{T statistic} = \frac{\text{Coefficient}}{\text{Standard deviation for that coefficient}}$$

The higher the T statistic the greater is the likelihood that the coefficient is statistically significant.

Standard error of the estimate

The standard error of the estimate is similar to the standard deviation because it indicates the standard deviation of the dependent variable given a specific value for the independent variables. Therefore, a higher r^2 will result in a lower standard error of estimate.

F statistic

The F statistic is a measure of how well the regression equation is a predictor of the dependent variable.

$$F = \frac{MSregression}{MSresidual}$$

Where MS = Mean Square

The calculated F statistic can be compared to a critical F statistic, taken from the tables. This critical value depends on the degrees of freedom for the numerator and denominator. As a rule of thumb, the F statistic at 95% confidence level with more than 10 observations should be greater or equal to 5. The more the calculated F statistic exceeds the critical value the greater the confidence that can be placed on the significance of the equation.

Multicollinearity

Multicollinearity indicates a problem in the multiple regression equation. As the correlation between two independent variables approaches one, the regression coefficient becomes less reliable and the confidence in the equation is destroyed. An acceptable guideline is that if the correlation between two independent variables is greater than .70 then the possibility of multicollinearity is present. The highest correlated variable of the two is usually dropped from the equation to remedy the problem.

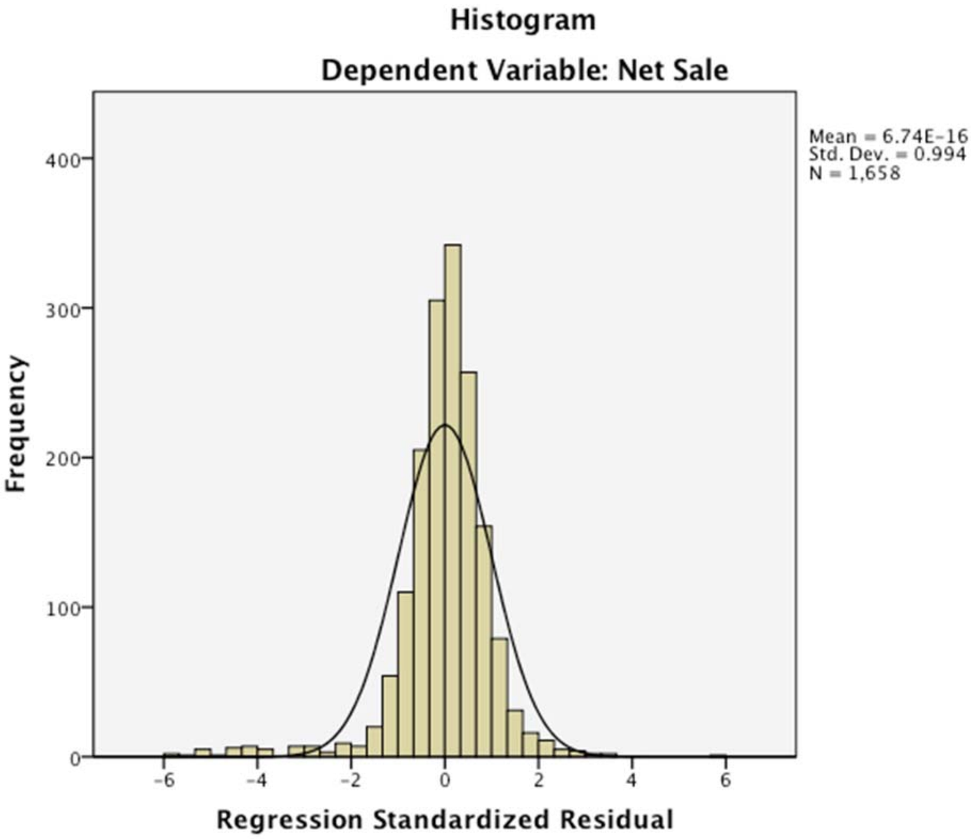
Durbin-Watson test

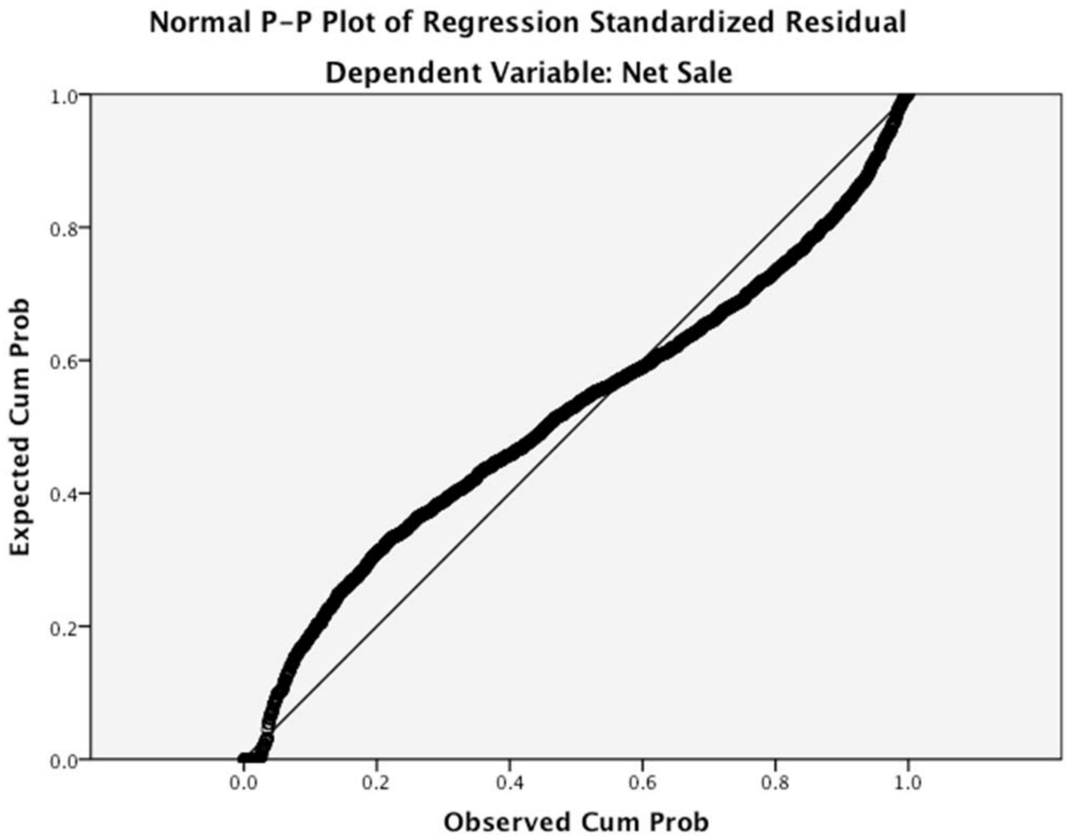
There is an assumption in regression analysis that the residual values are independent of each other; that is, not inter-related. The Durbin-Watson test is used to indicate whether the unexplained individual errors are independent of each other. The Durbin-Watson test has a breakdown as follows;

Durbin-Watson Statistic	**Interpretation**
2.0	Perfect independence – no autocorrelation (complete randomness)
1.5 - 2.5	Apparent independence (almost total randomness) – probably no autocorrelation
1.0 - 1.5 or 2.5 - 3.0	Some possibility of independence (considered a grey area concerning randomness)
0.0 -1.0 or 3.0 - 4.0	Probability of autocorrelation or serial correlation (non-randomness)

Appendix B

Regression tests and plots




Normal P-P Plot of Regression Standardized Residual
Dependent Variable: Net Sale
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0

Coefficient Diagnostics

Collinearity Diagnostics[a]

odel	Dimension	Eigen value	Condition Index	Variance Proportions (Constant)	Floor area	Sold 1998	Sold 1999	Sold 1997	land sqm	Roll 16780	Roll 16710	Built 1990s	unknown age	Sold 1994	Built 1980s	Built 1910s	Built 1930s	Roll 16730	Unknown roofing	Stone exterior	Fair con	Roughcast exterior	Built 1920s
	1	1.950	1.000	.02	.02																		
	2	.050	6.261	.98	.98																		
	1	2.212	1.000	.02	.02	.07																	
	2	.739	1.730	.01	.01	.93																	
	3	.049	6.687	.97	.97	.01																	
	1	2.286	1.000	.02	.02	.05	.02																
	2	1.000	1.512	.00	.00	.22	.68																
	3	.664	1.855	.01	.02	.72	.29																
	4	.049	6.806	.97	.97	.01	.00																
	1	2.501	1.000	.01	.01	.03	.01	.04															
	2	1.000	1.582	.00	.00	.46	.01	.29															
	3	1.000	1.582	.00	.00	.02	.77	.09															
	4	.450	2.358	.02	.03	.48	.20	.57															
	5	.049	7.158	.96	.95	.01	.00	.01															
	1	3.216	1.000	.01	.01	.02	.01	.02	.02														
	2	1.000	1.793	.00	.00	.44	.00	.31	.00														
	3	1.000	1.793	.00	.00	.03	.77	.07	.00														
	4	.527	2.469	.00	.01	.44	.18	.50	.10														
	5	.209	3.927	.05	.12	.05	.03	.08	.84														
	6	.047	8.234	.94	.87	.02	.01	.02	.04														
	1	3.528	1.000	.01	.01	.01	.01	.02	.02	.02													
	2	1.003	1.875	.00	.00	.00	.67	.18	.00	.01													
	3	1.000	1.878	.00	.00	.47	.08	.22	.00	.00													
	4	.696	2.251	.00	.00	.04	.05	.03	.01	.89													
	5	.523	2.597	.00	.01	.41	.16	.47	.12	.03													
	6	.202	4.181	.05	.13	.05	.02	.08	.81	.05													
	7	.047	8.625	.93	.86	.02	.01	.02	.04	.00													
	1	3.550	1.000	.01	.01	.01	.01	.01	.02	.02	.00												
	2	1.020	1.866	.00	.00	.03	.24	.16	.00	.01	.42												
	3	1.001	1.883	.00	.00	.39	.36	.06	.00	.00	.00												
	4	.985	1.899	.00	.00	.05	.15	.18	.00	.05	.45												
	5	.674	2.296	.00	.00	.04	.06	.03	.02	.83	.10												
	6	.523	2.605	.00	.01	.41	.16	.47	.12	.03	.00												
	7	.201	4.201	.05	.13	.05	.02	.08	.80	.05	.00												
	8	.047	8.716	.94	.86	.01	.01	.02	.04	.00	.02												
	1	3.602	1.000	.01	.01	.01	.01	.01	.02	.02	.00	.01											
	2	1.092	1.816	.00	.00	.10	.01	.09	.00	.06	.21	.33											
	3	1.006	1.892	.00	.00	.17	.62	.00	.00	.00	.06	.01											
	4	.986	1.911	.00	.00	.11	.11	.25	.00	.05	.32	.00											
	5	.911	1.988	.00	.00	.07	.01	.07	.00	.03	.33	.48											
	6	.632	2.386	.00	.00	.06	.05	.01	.02	.77	.05	.18											

7	.523	2.624	.00	.01	.41	.16	.47	.12	.03	.00	.00										
8	.201	4.233	.05	.13	.05	.02	.08	.80	.05	.00	.00										
9	.047	8.786	.94	.86	.01	.01	.02	.04	.00	.01	.00										
1	3.623	1.000	.01	.01	.01	.01	.01	.02	.02	.00	.00	.00									
2	1.102	1.813	.00	.00	.09	.02	.06	.00	.04	.20	.30	.08									
3	1.014	1.890	.00	.00	.13	.42	.01	.00	.02	.01	.03	.24									
4	.989	1.914	.00	.00	.05	.18	.03	.00	.02	.09	.00	.55									
5	.986	1.917	.00	.00	.11	.12	.26	.00	.04	.31	.00	.00									
6	.911	1.994	.00	.00	.08	.01	.06	.00	.03	.32	.48	.00									
7	.629	2.400	.00	.00	.09	.07	.03	.01	.74	.05	.18	.01									
8	.501	2.689	.00	.01	.39	.15	.45	.12	.05	.00	.00	.08									
9	.198	4.274	.05	.13	.04	.02	.07	.81	.05	.00	.00	.02									
10	.046	8.860	.94	.85	.01	.00	.01	.04	.00	.01	.00	.01									
1	3.807	1.000	.00	.01	.01	.00	.01	.02	.02	.00	.00	.00	.01								
2	1.116	1.847	.00	.00	.10	.05	.01	.00	.01	.13	.22	.18	.06								
3	1.063	1.893	.00	.00	.00	.03	.13	.00	.09	.08	.11	.15	.13								
4	1.005	1.946	.00	.00	.19	.50	.01	.00	.00	.08	.01	.00	.01								
5	.986	1.965	.00	.00	.09	.12	.23	.00	.04	.29	.00	.00	.00								
6	.923	2.031	.00	.00	.02	.02	.02	.00	.00	.02	.00	.58	.21								
7	.911	2.044	.00	.00	.07	.01	.05	.00	.03	.32	.48	.00	.00								
8	.629	2.460	.00	.00	.07	.06	.02	.02	.74	.05	.18	.01	.00								
9	.332	3.386	.00	.00	.29	.13	.32	.34	.02	.00	.00	.04	.40								
10	.183	4.558	.05	.18	.13	.06	.17	.58	.06	.00	.00	.01	.13								
11	.045	9.248	.94	.81	.03	.01	.04	.04	.00	.02	.00	.01	.04								
1	3.972	1.000	.00	.01	.01	.00	.01	.01	.01	.00	.00	.00	.01	.01							
2	1.140	1.867	.00	.00	.02	.01	.00	.00	.08	.31	.06	.13	.02	.11							
3	1.089	1.910	.00	.00	.10	.07	.00	.00	.07	.05	.10	.10	.11	.10							
4	1.056	1.939	.00	.00	.05	.01	.20	.00	.02	.00	.21	.12	.07	.03							
5	1.004	1.989	.00	.00	.12	.60	.04	.00	.00	.02	.00	.00	.01	.00							
6	.936	2.060	.00	.00	.09	.00	.19	.00	.02	.01	.32	.13	.03	.03							
7	.921	2.076	.00	.00	.09	.01	.00	.00	.00	.09	.11	.41	.17	.00							
8	.833	2.183	.00	.00	.01	.06	.00	.00	.14	.51	.01	.02	.02	.23							
9	.491	2.843	.00	.00	.07	.05	.05	.01	.56	.00	.18	.02	.01	.45							
10	.331	3.463	.00	.00	.28	.12	.30	.35	.03	.00	.00	.04	.39	.01							
11	.183	4.656	.05	.18	.13	.06	.17	.58	.06	.00	.00	.01	.13	.00							
12	.043	9.578	.94	.81	.03	.01	.03	.04	.00	.01	.00	.01	.04	.03							
1	3.986	1.000	.00	.01	.01	.00	.01	.01	.01	.00	.00	.00	.01	.01	.00						
2	1.148	1.864	.00	.00	.02	.00	.00	.00	.08	.30	.06	.10	.01	.13	.04						
3	1.091	1.911	.00	.00	.10	.08	.01	.00	.05	.02	.11	.13	.10	.08	.02						
4	1.057	1.942	.00	.00	.04	.00	.21	.00	.03	.01	.19	.12	.08	.02	.01						
5	1.019	1.977	.00	.00	.08	.33	.03	.00	.00	.04	.03	.01	.02	.00	.28						
6	.979	2.017	.00	.00	.06	.27	.00	.00	.01	.00	.03	.11	.00	.01	.43						
7	.928	2.072	.00	.00	.15	.01	.16	.00	.03	.00	.39	.00	.00	.03	.07						
8	.915	2.087	.00	.00	.02	.00	.03	.00	.00	.11	.00	.43	.19	.00	.12						
9	.833	2.188	.00	.00	.01	.06	.00	.00	.15	.50	.01	.02	.02	.22	.00						
10	.488	2.858	.00	.00	.08	.05	.05	.01	.55	.00	.18	.02	.01	.45	.01						

11	.330	3.478	.00	.00	.27	.12	.30	.35	.03	.00	.00	.05	.39	.01	.01							
12	.183	4.667	.05	.17	.13	.06	.17	.58	.06	.00	.00	.01	.12	.00	.00							
13	.043	9.612	.94	.81	.03	.01	.03	.03	.00	.01	.00	.01	.04	.03	.00							
1	3.998	1.000	.00	.01	.01	.00	.01	.01	.01	.00	.00	.00	.01	.01	.00	.00						
2	1.158	1.858	.00	.00	.02	.01	.00	.00	.07	.28	.07	.07	.01	.12	.03	.05						
3	1.092	1.913	.00	.00	.10	.09	.01	.00	.05	.03	.11	.09	.09	.09	.03	.01						
4	1.064	1.939	.00	.00	.01	.00	.20	.00	.02	.00	.09	.19	.09	.01	.03	.08						
5	1.028	1.972	.00	.00	.10	.29	.00	.00	.00	.01	.10	.00	.00	.01	.21	.11						
6	.985	2.015	.00	.00	.00	.02	.03	.00	.02	.02	.00	.18	.05	.00	.28	.34						
7	.976	2.024	.00	.00	.09	.27	.01	.00	.00	.02	.08	.00	.01	.02	.21	.20						
8	.927	2.077	.00	.00	.11	.02	.19	.00	.03	.00	.33	.02	.01	.03	.12	.01						
9	.904	2.103	.00	.00	.04	.00	.00	.00	.00	.21	.03	.32	.14	.00	.07	.13						
10	.826	2.200	.00	.00	.02	.07	.00	.00	.16	.41	.01	.03	.03	.21	.01	.05						
11	.486	2.867	.00	.00	.08	.05	.05	.01	.54	.00	.18	.02	.01	.45	.01	.01						
12	.329	3.483	.00	.00	.27	.12	.30	.35	.03	.00	.00	.05	.39	.01	.01	.00						
13	.183	4.674	.05	.17	.13	.06	.17	.58	.06	.00	.00	.01	.12	.00	.00	.00						
14	.043	9.660	.94	.81	.03	.01	.03	.03	.00	.01	.00	.01	.04	.03	.00	.01						
1	4.068	1.000	.00	.00	.01	.00	.01	.01	.01	.00	.00	.00	.01	.01	.00	.00	.00					
2	1.219	1.827	.00	.00	.02	.00	.00	.00	.10	.10	.08	.05	.01	.10	.02	.04	.15					
3	1.092	1.930	.00	.00	.10	.09	.01	.00	.05	.04	.11	.09	.08	.09	.03	.01	.00					
4	1.069	1.951	.00	.00	.01	.02	.16	.00	.02	.04	.08	.20	.09	.03	.03	.03	.03					
5	1.038	1.980	.00	.00	.04	.30	.03	.00	.00	.14	.02	.00	.01	.01	.09	.14	.05					
6	.999	2.018	.00	.00	.01	.01	.01	.00	.01	.18	.08	.07	.00	.02	.40	.02	.13					
7	.984	2.033	.00	.00	.00	.00	.04	.00	.01	.07	.02	.13	.06	.00	.10	.49	.01					
8	.962	2.057	.00	.00	.18	.25	.00	.00	.01	.13	.06	.00	.01	.00	.10	.04	.09					
9	.925	2.098	.00	.00	.06	.03	.18	.00	.02	.04	.26	.05	.02	.04	.16	.00	.01					
10	.889	2.139	.00	.00	.04	.06	.00	.00	.01	.00	.05	.32	.15	.01	.04	.21	.05					
11	.718	2.381	.00	.00	.03	.02	.00	.00	.12	.25	.06	.00	.00	.22	.00	.00	.45					
12	.486	2.893	.00	.00	.08	.05	.05	.01	.54	.00	.17	.02	.02	.43	.01	.01	.00					
13	.328	3.524	.00	.00	.26	.11	.29	.37	.03	.00	.00	.05	.38	.01	.01	.00	.01					
14	.181	4.747	.05	.18	.13	.06	.18	.57	.07	.00	.00	.01	.13	.00	.00	.00	.02					
15	.043	9.748	.94	.81	.03	.01	.03	.03	.00	.01	.00	.01	.04	.03	.00	.01	.00					
1	4.083	1.000	.00	.00	.01	.00	.01	.01	.01	.00	.00	.00	.01	.01	.00	.00	.00	.00				
2	1.239	1.816	.00	.00	.03	.00	.00	.00	.05	.07	.05	.18	.01	.06	.01	.02	.12	.10				
3	1.169	1.869	.00	.00	.00	.00	.02	.00	.08	.03	.03	.17	.01	.04	.02	.05	.04	.22				
4	1.087	1.938	.00	.00	.11	.06	.08	.00	.02	.05	.18	.00	.02	.11	.04	.04	.00	.01				
5	1.042	1.979	.00	.00	.03	.35	.00	.00	.01	.17	.02	.00	.03	.01	.00	.10	.09	.01				
6	1.024	1.997	.00	.00	.03	.00	.09	.00	.02	.00	.02	.00	.16	.00	.39	.01	.00	.04				
7	.993	2.028	.00	.00	.00	.00	.06	.00	.00	.25	.08	.00	.05	.02	.06	.25	.11	.01				
8	.963	2.059	.00	.00	.17	.23	.01	.00	.01	.11	.07	.01	.00	.00	.02	.13	.10	.00				
9	.937	2.087	.00	.00	.00	.01	.07	.00	.02	.05	.03	.00	.08	.00	.43	.17	.00	.07				
10	.917	2.111	.00	.00	.10	.05	.10	.00	.00	.01	.27	.00	.02	.07	.00	.20	.03	.04				
11	.813	2.240	.00	.00	.00	.02	.00	.00	.00	.03	.01	.52	.03	.02	.00	.01	.07	.38				
12	.707	2.403	.00	.00	.03	.03	.00	.00	.14	.23	.05	.03	.00	.18	.00	.00	.41	.07				
13	.481	2.914	.00	.00	.07	.04	.05	.02	.53	.00	.18	.04	.01	.44	.01	.01	.00	.02				
14	.326	3.539	.00	.00	.27	.11	.30	.35	.03	.00	.00	.04	.39	.00	.01	.00	.01	.01				

11	.330	3.478	.00	.00	.27	.12	.30	.35	.03	.00	.00	.05	.39	.01	.01							
12	.183	4.667	.05	.17	.13	.06	.17	.58	.06	.00	.00	.01	.12	.00	.00							
13	.043	9.612	.94	.81	.03	.01	.03	.03	.00	.01	.00	.01	.04	.03	.00							
1	3.998	1.000	.00	.01	.01	.00	.01	.01	.01	.00	.00	.00	.01	.01	.00	.00						
2	1.158	1.858	.00	.00	.02	.01	.00	.00	.07	.28	.07	.07	.01	.12	.03	.05						
3	1.092	1.913	.00	.00	.10	.09	.01	.00	.05	.03	.11	.09	.09	.09	.03	.01						
4	1.064	1.939	.00	.00	.01	.00	.20	.00	.02	.00	.09	.19	.09	.01	.03	.08						
5	1.028	1.972	.00	.00	.10	.29	.00	.00	.00	.01	.10	.00	.00	.01	.21	.11						
6	.985	2.015	.00	.00	.00	.02	.03	.00	.02	.02	.00	.18	.05	.00	.28	.34						
7	.976	2.024	.00	.00	.09	.27	.01	.00	.00	.02	.08	.00	.01	.02	.21	.20						
8	.927	2.077	.00	.00	.11	.02	.19	.00	.03	.00	.33	.02	.01	.03	.12	.01						
9	.904	2.103	.00	.00	.04	.00	.00	.00	.00	.21	.03	.32	.14	.00	.07	.13						
10	.826	2.200	.00	.00	.02	.07	.00	.00	.16	.41	.01	.03	.03	.21	.01	.05						
11	.486	2.867	.00	.00	.08	.05	.05	.01	.54	.00	.18	.02	.01	.45	.01	.01						
12	.329	3.483	.00	.00	.27	.12	.30	.35	.03	.00	.00	.05	.39	.01	.01	.00						
13	.183	4.674	.05	.17	.13	.06	.17	.58	.06	.00	.00	.01	.12	.00	.00	.00						
14	.043	9.660	.94	.81	.03	.01	.03	.03	.00	.01	.00	.01	.04	.03	.00	.01						
1	4.068	1.000	.00	.00	.01	.00	.01	.01	.01	.00	.00	.00	.01	.01	.00	.00	.00					
2	1.219	1.827	.00	.00	.02	.00	.00	.00	.10	.10	.08	.05	.01	.10	.02	.04	.15					
3	1.092	1.930	.00	.00	.10	.09	.01	.00	.05	.04	.11	.09	.08	.09	.03	.01	.00					
4	1.069	1.951	.00	.00	.01	.02	.16	.00	.02	.04	.08	.20	.09	.03	.03	.03	.03					
5	1.038	1.980	.00	.00	.04	.30	.03	.00	.00	.14	.02	.00	.01	.01	.09	.14	.05					
6	.999	2.018	.00	.00	.01	.01	.01	.00	.01	.18	.08	.07	.00	.02	.40	.02	.13					
7	.984	2.033	.00	.00	.00	.00	.04	.00	.01	.07	.02	.13	.06	.00	.10	.49	.01					
8	.962	2.057	.00	.00	.18	.25	.00	.00	.01	.13	.06	.00	.01	.00	.10	.04	.09					
9	.925	2.098	.00	.00	.06	.03	.18	.00	.02	.04	.26	.05	.02	.04	.16	.00	.01					
10	.889	2.139	.00	.00	.04	.06	.00	.00	.01	.00	.05	.32	.15	.01	.04	.21	.05					
11	.718	2.381	.00	.00	.03	.02	.00	.00	.12	.25	.06	.00	.00	.22	.00	.00	.45					
12	.486	2.893	.00	.00	.08	.05	.05	.01	.54	.00	.17	.02	.02	.43	.01	.01	.00					
13	.328	3.524	.00	.00	.26	.11	.29	.37	.03	.00	.00	.05	.38	.01	.01	.00	.01					
14	.181	4.747	.05	.18	.13	.06	.18	.57	.07	.00	.00	.01	.13	.00	.00	.00	.02					
15	.043	9.748	.94	.81	.03	.01	.03	.03	.00	.01	.00	.01	.04	.03	.00	.01	.00					
1	4.083	1.000	.00	.00	.01	.00	.01	.01	.01	.00	.00	.00	.01	.01	.00	.00	.00	.00				
2	1.239	1.816	.00	.00	.03	.00	.00	.00	.05	.07	.05	.18	.01	.06	.01	.02	.12	.10				
3	1.169	1.869	.00	.00	.00	.00	.02	.00	.08	.03	.03	.17	.01	.04	.02	.05	.04	.22				
4	1.087	1.938	.00	.00	.11	.06	.08	.00	.02	.05	.18	.00	.02	.11	.04	.04	.00	.01				
5	1.042	1.979	.00	.00	.03	.35	.00	.00	.01	.17	.02	.00	.03	.01	.00	.10	.09	.01				
6	1.024	1.997	.00	.00	.03	.00	.09	.00	.02	.00	.02	.00	.16	.00	.39	.01	.00	.04				
7	.993	2.028	.00	.00	.00	.00	.06	.00	.00	.25	.08	.00	.05	.02	.06	.25	.11	.01				
8	.963	2.059	.00	.00	.17	.23	.01	.00	.01	.11	.07	.01	.00	.00	.02	.13	.10	.00				
9	.937	2.087	.00	.00	.00	.01	.07	.00	.02	.05	.03	.00	.08	.00	.43	.17	.00	.07				
10	.917	2.111	.00	.00	.10	.05	.10	.00	.00	.01	.27	.00	.02	.07	.00	.20	.03	.04				
11	.813	2.240	.00	.00	.00	.02	.00	.00	.00	.03	.01	.52	.03	.02	.00	.01	.07	.38				
12	.707	2.403	.00	.00	.03	.03	.00	.00	.14	.23	.05	.03	.00	.18	.00	.00	.41	.07				
13	.481	2.914	.00	.00	.07	.04	.05	.02	.53	.00	.18	.04	.01	.44	.01	.01	.00	.02				
14	.326	3.539	.00	.00	.27	.11	.30	.35	.03	.00	.00	.04	.39	.00	.01	.00	.01	.01				

10	.953	2.090	.00	.00	.02	.12	.04	.00	.00	.22	.01	.10	.03	.01	.04	.16	.15	.00	.01	.01	.00	
11	.932	2.114	.00	.00	.01	.17	.03	.00	.01	.01	.00	.29	.04	.01	.06	.04	.01	.00	.03	.20	.02	
12	.840	2.227	.00	.00	.03	.01	.00	.00	.01	.00	.02	.06	.10	.05	.14	.20	.01	.00	.01	.39	.00	
13	.760	2.341	.00	.00	.02	.01	.03	.00	.00	.02	.23	.00	.00	.13	.07	.01	.12	.00	.03	.01	.44	
14	.714	2.415	.00	.00	.02	.01	.01	.00	.13	.20	.18	.01	.00	.10	.01	.00	.36	.01	.01	.01	.11	
15	.538	2.782	.00	.00	.01	.01	.02	.00	.04	.04	.00	.13	.00	.00	.00	.00	.01	.61	.57	.00	.02	
16	.474	2.964	.00	.00	.08	.04	.05	.02	.49	.00	.19	.05	.01	.43	.01	.00	.00	.03	.01	.02	.00	
17	.322	3.598	.00	.00	.27	.11	.29	.34	.04	.00	.00	.03	.39	.00	.01	.00	.01	.03	.03	.00	.00	
18	.177	4.857	.05	.18	.12	.06	.17	.58	.07	.00	.00	.00	.12	.00	.00	.00	.01	.02	.00	.00	.01	
19	.042	9.940	.94	.80	.03	.01	.03	.04	.00	.01	.00	.01	.04	.04	.00	.01	.00	.01	.00	.01	.00	
1	4.171	1.000	.00	.00	.01	.00	.01	.01	.01	.00	.00	.00	.01	.01	.00	.00	.00	.00	.00	.00	.00	.00
2	1.444	1.700	.00	.00	.00	.00	.01	.00	.00	.00	.00	.04	.00	.00	.00	.00	.01	.25	.23	.01	.00	.00
3	1.266	1.815	.00	.00	.02	.00	.01	.00	.05	.01	.22	.03	.01	.00	.00	.01	.10	.00	.00	.00	.19	.00
4	1.188	1.874	.00	.00	.00	.00	.00	.00	.04	.16	.04	.03	.00	.18	.05	.03	.03	.00	.01	.00	.13	.00
5	1.105	1.943	.00	.00	.01	.09	.02	.00	.06	.01	.01	.19	.14	.01	.02	.02	.02	.00	.04	.06	.00	.02
6	1.066	1.979	.00	.00	.02	.16	.07	.00	.03	.00	.02	.00	.00	.01	.00	.23	.01	.01	.00	.19	.02	.01
7	1.029	2.013	.00	.00	.19	.09	.02	.00	.00	.01	.00	.02	.01	.01	.04	.00	.00	.00	.01	.00	.02	.40
8	1.024	2.018	.00	.00	.00	.02	.07	.00	.01	.01	.03	.00	.03	.00	.50	.02	.00	.00	.00	.07	.00	.07
9	1.002	2.041	.00	.00	.02	.01	.01	.00	.00	.28	.04	.03	.05	.01	.03	.16	.16	.01	.00	.01	.01	.06
10	.969	2.075	.00	.00	.11	.03	.15	.00	.00	.00	.00	.00	.02	.00	.00	.19	.01	.00	.00	.00	.02	.31
11	.952	2.094	.00	.00	.05	.14	.01	.00	.00	.23	.00	.13	.03	.01	.04	.09	.13	.00	.01	.01	.00	.04
12	.931	2.116	.00	.00	.00	.19	.02	.00	.01	.01	.00	.26	.03	.01	.07	.03	.01	.00	.03	.21	.02	.01
13	.834	2.237	.00	.00	.03	.02	.01	.00	.01	.00	.02	.06	.10	.05	.13	.19	.00	.00	.01	.37	.00	.04
14	.760	2.343	.00	.00	.02	.01	.03	.00	.00	.02	.23	.00	.00	.13	.07	.01	.12	.00	.03	.01	.45	.00
15	.713	2.419	.00	.00	.02	.01	.00	.00	.12	.20	.18	.01	.00	.10	.01	.00	.36	.01	.01	.02	.11	.01
16	.538	2.785	.00	.00	.00	.01	.02	.00	.04	.04	.00	.13	.00	.00	.00	.00	.01	.62	.57	.00	.02	.00
17	.468	2.985	.00	.00	.08	.04	.05	.02	.50	.00	.19	.05	.01	.42	.01	.00	.00	.03	.00	.02	.00	.02
18	.322	3.601	.00	.00	.27	.11	.29	.34	.04	.00	.00	.03	.39	.00	.01	.00	.01	.03	.03	.00	.00	.00
19	.176	4.862	.05	.18	.12	.06	.16	.58	.07	.00	.00	.00	.12	.00	.00	.00	.01	.02	.00	.00	.01	.00
20	.042	9.950	.94	.80	.03	.01	.03	.04	.00	.01	.00	.01	.04	.04	.00	.01	.00	.01	.00	.00	.00	.00

Dependent Variable: Net Sale

Appendix C

Final regression output for the case study area

Model Summary[t]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.520[a]	.270	.270	31980.50429	.270	613.730	1	1656	.000	
2	.579[b]	.335	.334	30542.18875	.065	160.644	1	1655	.000	
3	.624[c]	.389	.388	29287.70884	.054	145.814	1	1654	.000	
4	.650[d]	.423	.421	28473.99377	.034	96.885	1	1653	.000	
5	.671[e]	.451	.449	27781.51499	.028	84.432	1	1652	.000	
6	.687[f]	.472	.470	27246.20991	.021	66.551	1	1651	.000	
7	.702[g]	.492	.490	26725.48137	.020	65.964	1	1650	.000	
8	.711[h]	.506	.503	26376.56403	.013	44.942	1	1649	.000	
9	.718[i]	.515	.513	26128.69027	.010	32.435	1	1648	.000	
10	.722[j]	.521	.518	25983.17478	.006	19.511	1	1647	.000	
11	.725[k]	.526	.523	25862.55788	.005	16.398	1	1646	.000	
12	.727[l]	.528	.525	25799.40911	.003	9.068	1	1645	.003	
13	.728[m]	.530	.527	25748.52325	.002	7.508	1	1644	.006	
14	.730[n]	.533	.529	25699.83861	.002	7.235	1	1643	.007	
15	.731[o]	.534	.530	25655.34015	.002	6.704	1	1642	.010	
16	.732[p]	.536	.532	25607.44777	.002	7.148	1	1641	.008	
17	.734[q]	.538	.533	25569.84116	.002	5.831	1	1640	.016	
18	.734[r]	.539	.534	25547.09248	.001	3.922	1	1639	.048	
19	.735[s]	.540	.535	25524.77226	.001	3.868	1	1638	.049	1.853

Appendix D

Coefficients summary

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	73890.090	2521.263		29.307	.000					
	Floor area	461.247	18.618	.520	24.774	.000	.520	.520	.520	1.000	1.000
2	(Constant)	69527.671	2432.345		28.585	.000					
	Floor area	462.060	17.781	.521	25.986	.000	.520	.538	.521	1.000	1.000
	Sold 1998	25485.339	2010.752	.254	12.675	.000	.252	.297	.254	1.000	1.000
3	(Constant)	66941.237	2342.254		28.580	.000					
	Floor area	461.496	17.051	.520	27.066	.000	.520	.554	.520	1.000	1.000
	Sold 1998	28144.086	1940.694	.281	14.502	.000	.252	.336	.279	.987	1.013
	Sold 1999	36720.470	3040.950	.234	12.075	.000	.203	.285	.232	.987	1.013
4	(Constant)	62439.449	2322.653		26.883	.000					
	Floor area	459.753	16.578	.518	27.732	.000	.520	.563	.518	1.000	1.000
	Sold 1998	32869.584	1946.895	.328	16.883	.000	.252	.384	.316	.927	1.079
	Sold 1999	41447.469	2995.212	.264	13.838	.000	.203	.322	.259	.962	1.040
	Sold 1997	17702.327	1798.465	.191	9.843	.000	.088	.235	.184	.923	1.083
5	(Constant)	54550.499	2423.349		22.510	.000					
	Floor area	444.529	16.260	.501	27.339	.000	.520	.558	.499	.989	1.011
	Sold 1998	33672.860	1901.558	.336	17.708	.000	.252	.399	.323	.925	1.081
	Sold 1999	42462.021	2924.455	.270	14.520	.000	.203	.336	.265	.960	1.041
	Sold 1997	18843.725	1759.118	.204	10.712	.000	.088	.255	.195	.919	1.088
	land sqm	14.088	1.533	.169	9.189	.000	.193	.221	.168	.983	1.017
6	(Constant)	55800.784	2381.591		23.430	.000					
	Floor area	461.301	16.078	.520	28.691	.000	.520	.577	.513	.973	1.027
	Sold 1998	33840.646	1865.031	.337	18.145	.000	.252	.408	.324	.925	1.081
	Sold 1999	43373.034	2870.278	.276	15.111	.000	.203	.349	.270	.959	1.043
	Sold 1997	18725.324	1725.283	.202	10.853	.000	.088	.258	.194	.919	1.088
	land sqm	13.672	1.504	.164	9.087	.000	.193	.218	.163	.982	1.018
	Roll 16780	-12709.944	1557.993	-.147	-8.158	.000	-.074	-.197	-.146	.981	1.019
7	(Constant)	58467.470	2359.035		24.784	.000					

	Sold 1997	18482.093	1670.378	.200	11.065	.000	.088	.263	.192	.919	1.089
	land sqm	13.100	1.458	.157	8.988	.000	.193	.216	.156	.981	1.020
	Roll 16780	-12603.035	1523.850	-.146	-8.271	.000	-.074	-.200	-.143	.961	1.040
	Roll 16710	-35013.746	4160.815	-.147	-8.415	.000	-.175	-.203	-.146	.982	1.019
	Built 1990s	21574.560	3218.215	.118	6.704	.000	.152	.163	.116	.975	1.025
9	(Constant)	58856.612	2322.838		25.338	.000					
	Floor area	445.085	15.515	.502	28.687	.000	.520	.577	.492	.961	1.040
	Sold 1998	33218.415	1797.422	.331	18.481	.000	.252	.414	.317	.916	1.092
	Sold 1999	43521.427	2757.938	.277	15.780	.000	.203	.362	.271	.955	1.047
	Sold 1997	18760.363	1655.402	.203	11.333	.000	.088	.269	.194	.918	1.090
	land sqm	11.550	1.469	.139	7.861	.000	.193	.190	.135	.947	1.056
	Roll 16780	-12450.816	1509.766	-.144	-8.247	.000	-.074	-.199	-.141	.961	1.040
	Roll 16710	-34961.368	4121.724	-.147	-8.482	.000	-.175	-.205	-.145	.982	1.019
	Built 1990s	21967.473	3188.718	.120	6.889	.000	.152	.167	.118	.975	1.026
	unknown age	35191.198	6179.091	.100	5.695	.000	.154	.139	.098	.952	1.050
10	(Constant)	61858.820	2407.824		25.691	.000					
	Floor area	444.768	15.429	.501	28.827	.000	.520	.579	.492	.961	1.040
	Sold 1998	30321.856	1903.909	.302	15.926	.000	.252	.365	.272	.807	1.239
	Sold 1999	40674.865	2817.277	.259	14.438	.000	.203	.335	.246	.905	1.105
	Sold 1997	15857.499	1772.517	.171	8.946	.000	.088	.215	.153	.792	1.263
	land sqm	11.699	1.462	.140	8.005	.000	.193	.194	.137	.947	1.056
	Roll 16780	-13079.705	1508.094	-.152	-8.673	.000	-.074	-.209	-.148	.953	1.050
	Roll 16710	-35424.331	4100.109	-.149	-8.640	.000	-.175	-.208	-.147	.981	1.019
	Built 1990s	22135.699	3171.188	.121	6.980	.000	.152	.170	.119	.975	1.026
	unknown age	35887.227	6146.698	.102	5.838	.000	.154	.142	.100	.951	1.051
	Sold 1994	-7782.068	1761.816	-.085	-4.417	.000	-.211	-.108	-.075	.784	1.275
11	(Constant)	59914.198	2444.283		24.512	.000					
	Floor area	450.987	15.434	.508	29.221	.000	.520	.584	.496	.952	1.051
	Sold 1998	29979.424	1896.957	.299	15.804	.000	.252	.363	.268	.806	1.241
	Sold 1999	40304.252	2805.692	.256	14.365	.000	.203	.334	.244	.904	1.106
	Sold 1997	15470.635	1766.874	.167	8.756	.000	.088	.211	.149	.789	1.267
	land sqm	11.277	1.458	.135	7.732	.000	.193	.187	.131	.942	1.062
	Roll 16780	-11632.425	1543.053	-.135	-7.539	.000	-.074	-.183	-.128	.901	1.109

Built 1990s	24215.706	3180.131	.132	7.615	.000	.152	.185	.129	.956	1.046
unknown age	37655.567	6113.669	.107	6.159	.000	.154	.150	.104	.948	1.055
Sold 1994	-7815.005	1749.437	-.085	-4.467	.000	-.211	-.109	-.076	.784	1.275
Built 1980s	7726.614	1823.150	.076	4.238	.000	.023	.104	.072	.897	1.115
Built 1910s	17161.195	5699.025	.051	3.011	.003	.030	.074	.051	.988	1.012

a. Dependent Variable: Net Sale

Appendix E

Description for all variables used in regression model

Variable	Description
Net Sale	Amount house sold for, net of chattels
Arterial	Dummy for whether property is on a main arterial route or not.
Floor Area	Floor area of house measured in square metres.
Land.Area	Lot area measured in square metres
GV	Government /Rating Valuation
Built 1910s	House constructed in 1910s
Built 1920s	House constructed in 1920s
Built 1930s	House constructed in 1930s
Built 1940s	House constructed in 1940s
Built 1950s	House constructed in 1950s
Built 1960s	House constructed in 1960s
Built 1970s	House constructed in 1970s
Built 1980s	House constructed in 1980s
Built 1990s	House constructed in 1990s
Built 2000s	House constructed in 2000s
Unknown age	The year the house was constructed is unknown
View1	Panoramic View
View2	View across valley
View3	No view
Ex condition	Condition of exterior cladding and roofing materials is very good.
Avg condition	Condition of exterior is Average condition
Fair condition	Condition of exterior is fair condition
Poor condition	Condition of exterior is poor condition
Unknown cond	Condition of house was unknown at time of sale
Sold 1994	Sale was made in 1994
Sold 1995	Sale was made in 1995
Sold 1996	Sale was made in 1996
Sold 1997	Sale was made in 1997
Sold 1998	Sale was made in 1998
Sold 1999	Sale was made in 1999
Sold 2000	Sale was made in 2000
Weatherboard exterior	Weatherboard Exterior Cladding

Aluminium exterior	Aluminium exterior cladding
Brick exterior	Brick exterior cladding
Fibrolite exterior	Fibrolite exterior cladding
Plastic exterior	Exterior cladding is plastic material
Unknown cladding	Exterior cladding is an unknown material at time of sale
Tiled roof	Tile roof
Fibrolite roof	Fibrolite roof
Malthoid roof	Malthoid roof
Unknown roof	Roofing material is unknown
Iron roof	Iron roof

Suburbs in New Zealand are split into Roll numbers for rating valuation purposes. The following rolls cover the suburbs of Newlands and Johnsonville East.

Roll 16710
Roll 16719
Roll 16720
Roll 16721
Roll 16730
Roll 16740
Roll 16760
Roll 16770
Roll 16780

Appendix F

Repeat Sales Table

Sales - Case Study area

Sale		**sale price**	**date**	**sale price**	**date**	**sale price**	**date**
1	37 Sunhaven Drive	$271,000	10Aug09			$91,000	18Jul94
2	39 Sunhaven Drive	$226,500	5Apr05	$97,000	15Aug96	$87,000	10Jun94
3	6a Sunhaven Drive	$415,550	26Mar08	$240,000	17Jul03	$130,000	19Sep93
4	20 Somers Cres	$243,000	9Mar01			$147,000	8Jul95
5	37 Edgecombe Street	$405,000	5Nov09	$177,500	14Aug98	$160,000	5Sep95
6	31 Edgecombe Street	$230,000	5Jan05			$129,000	6Jul94

Sales – Control area

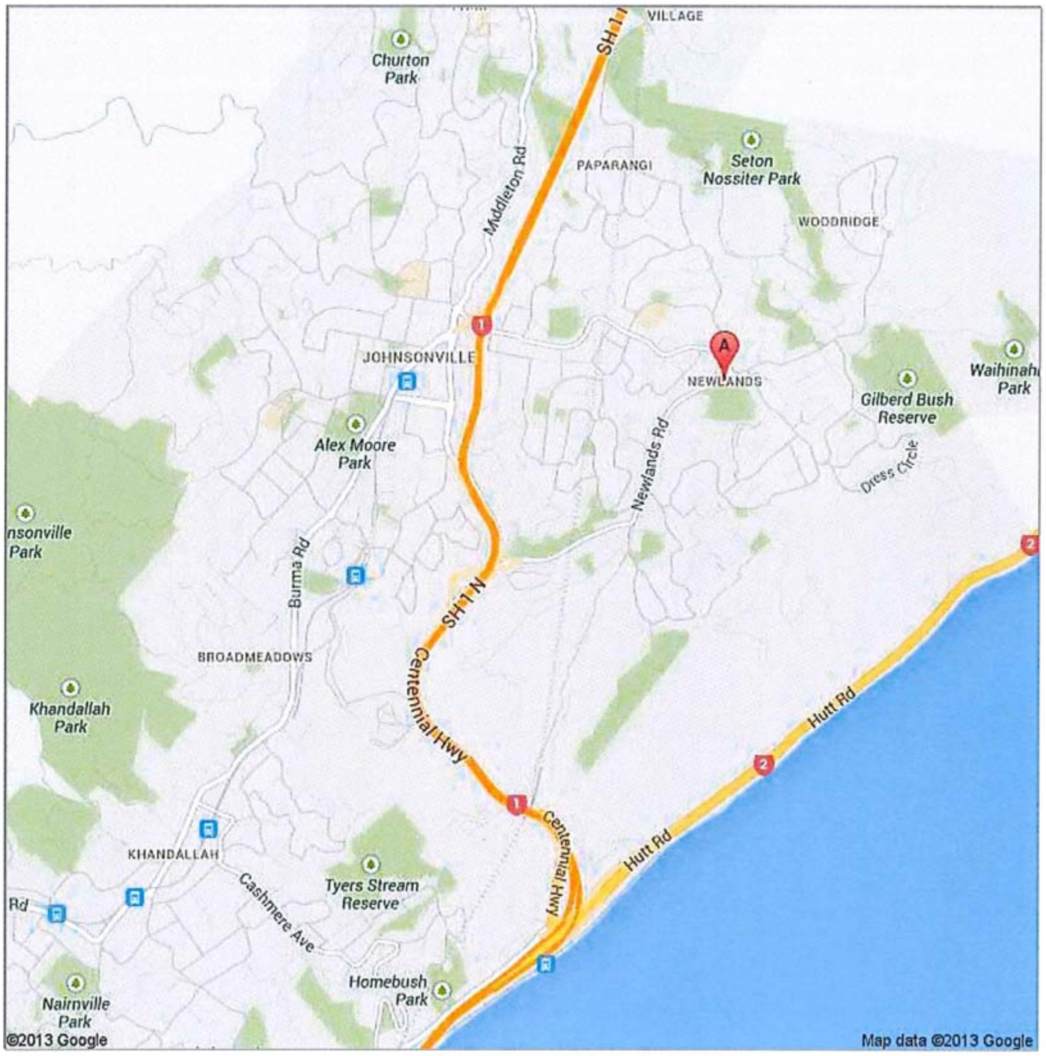
Sale		sale price	date	sale price	date	sale price	date
1	50 Chapman Street	$295,200	19Jun03			$198,000	24May95
2	10 Fitzpatrick Street	$287,500	2Jan05			$102,000	9Dec94
3	17 Fitzpatrick Street	$188,500	6Feb02	$166,500	24Jun98	$153,300	22Jun97
				$140,000	18Jun95	$128,000	9Mar94
4	54 Ruskin Street	$350,000	23Aug07	$132,500	25Mar99	$101,500	31Aug95
5	59 Ruskin Street	$185,000	1Apr01			$112,000	13Aug94
6	10 Salford Street	$310,000	9Sep04			$157,500	24Feb95

Appendix G

Map of study area – Newlands

The 'A' symbol identifies the Newlands area.

Google Address **Newlands, Wellington New Zealand**



Appendix H

Map of study area in relation to Wellington, New Zealand

The ‘A’ symbol identifies the Newlands area.